F. L. Heward.
Aust. Staff Corps.

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MANUAL OF INJURIES AND DISEASES OF WAR (AUSTRALIA) 1939.

(Serial No.1)

Page 28 - Insert new paragraph :-

(Serial No.1 - February, 1940.)

"Transport of Men Suffering from Facial Injuries.

Attention is drawn to the necessity for care in transporting wounded men who are suffering from Fractures of the Lower Jaw.

Medical Officers and Stretcher Bearers should be instructed to carry all cases of fractures of the lower jaw on stretchers face downwards. The danger of suffocation due to loss of control of the tongue in fracture of the lower jaw is a very real one. If the patient shows signs of suffocation the tongue should be seized with a pair of forceps and pulled forward or a suture placed through it, any loose material should be removed from the throat and the man carried in the face downwards position. If the wounded man is able to walk he should be instructed to stoop well forward.

The earlier that skilled attention can be given to fractures of the jaw the better will be the final result."

[*Notified in Army Orders for January*, 1935

ARMY MANUAL OF HYGIENE AND SANITATION 1934

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P.636.—1.

PREFACE

The special object of this manual is the instruction and guidance of regimental officers, and of warrant officers, non-commissioned officers and men of all arms, in the preservation and promotion of health and the prevention of disease, and in the performance of the duties necessary for good sanitation.

It is intended also to be a guide and reference book for officer and non-commissioned officer instructors engaged in the training of the sanitary personnel of the Army. In addition, it is intended to be a handy reference book in all matters of sanitation under the varying conditions of military service.

Chapters I–XII and Appendices 1, 7, 8, 9, 10 and 17 affect all arms, Chapter XIII is primarily for the information and guidance of Staff and Medical Officers. The remaining Appendices are for the guidance of officers and other ranks of the Medical Services and, where applicable, of water duty and sanitary personnel of combatant units.

By Command of the Army Council,

H. J. Creedy

THE WAR OFFICE,
31*st January*, 1935

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CHAPTER I

INTRODUCTION

The Army is an organization with vast responsibilities both at home and abroad, and in order to achieve its object with the greatest economy every man must not only be fully trained but must also be physically fit to carry out his duties in any part of the world. As the efficiency of a soldier depends so largely on his physical fitness, the importance of maintaining him in a good state of health cannot be overestimated.

Physical fitness can be attained either by the prevention of disease or by curing existing disease, and there is no doubt that the former is the easier and more economical method, as sick men, in addition to reducing the fighting strength of a force, require elaborate arrangements for their treatment, feeding, transport, etc., which otherwise could be concentrated on dealing with the wounded.

The maintenance and promotion of the health of the troops and the prevention of disease are not the concern of the Medical Services alone, but are the duty of every officer, non-commissioned officer and man in the Army and can only be carried out if every one is conversant with the laws of health, the scientific reasons for these laws, and the methods by which they can be put into practice.

Ignorance of the laws of hygiene is the cause of most of the outbreaks of diseases, but sanitary discipline is also of the greatest importance. Breaking the laws of hygiene brings retribution as certainly and quickly as breaking the laws of the State.

The majority of the diseases which affect armies are preventable, and a study of past campaigns shows that many more men are disabled by sickness than by enemy action (*see* Appx. I). In the Peninsular War three times as many men were lost from sickness as from wounds, and more than

twice the strength of the Army were admitted to hospital on account of disease.

In the Crimean War, 1854–56, in the British Army 89 men per 1,000 died of disease and only 17 per 1,000 were killed in action or died of wounds, while the French Army lost 114 per 1,000 from disease compared with 30 per 1,000 killed or died of wounds.

Instances have occurred where armies have been decimated by disease before reaching the scene of operations and also where expeditions have had to be abandoned owing to the ravages of diseases in camps.

A comparison of the last two great campaigns fought by the British Army gives a striking example of the reduction of disease by improved sanitation and preventive measures. In the South African War, 1899–1902, with a British force of 208,000 men, there were 57,684 cases of typhoid fever, of which 8,022 were fatal, whereas in the Great War of 1914–1918, with approximately six millions British, Dominion and Indian troops engaged in numerous theatres of war, there was a total of 31,011 cases of typhoid, of which only 777 were fatal. This remarkable reduction was undoubtedly due to the increased attention paid to sanitation, inoculation of personnel and purification of water supplies. The Great War, however, was fought on many fronts and while in France and Flanders the proportion of admissions to hospital was 1·3 sick to one wounded, in Macedonia it was 27·1 and in East Africa it reached 33·1, as a result of malaria in Macedonia and intestinal diseases in Africa.

Lack of military medical intelligence in regard to malaria in Macedonia before the campaign began, with the resultant occupation of intensely malarious valleys during the malarial season and under conditions which rendered the prevention of malaria impracticable, resulted in 161,000 admissions to hospital from this disease.

It is evident, therefore, that disease is responsible for from three to four times as many casualties as enemy action during a campaign, and it is only by ceaseless attention to sanitation that sickness can be combated and the Army maintained in a condition to carry out its object, which is to break down the resistance of the enemy.

Although disease produces its most serious effect on troops on active service, the maintenance of the health of the soldier in peace must never be lost sight of, since the time spent by men in hospital is not only an extra expense to the State but is time lost in their training.

The soldier is taught in peace time the use of the weapons which he will be called upon to use in war and he must also be

instructed and practised in sanitation so that he will acquire the habits of sanitary observance which are necessary to the maintenance of his health.

Responsibility

King's Regulations, 1928, para. 71, lays down that officers will pay particular attention to the preservation of the health of the troops, and the responsibility for remedying sanitary defects rests upon commanding officers and through them on subordinate commanders. Furthermore, Field Service Regulations, Volume I, 1930, Sect. 145, states that " the commander of every formation and unit in the field will be responsible for the sanitary condition of the area occupied by his command, irrespective of the period for which it may be occupied, and for the enforcement of all orders regarding health and sanitation."

It will be seen, therefore, that the responsibility for sanitation and the preservation of the health of the men devolves on the commander of every formation ; this includes not only the higher commanders but also the most junior platoon commander or the non-commissioned officer or man in charge of any detachment. In order that every such commander may be in a position to bear this sanitary responsibility, he must have a knowledge of the laws of health, must understand the reasons for them and must see that they are obeyed.

A commander must necessarily delegate certain duties to others specially trained in those duties, and accordingly he allots sanitary duties to trained sanitary personnel while he himself is responsible for seeing that such duties are carried out. Sanitation, therefore, becomes a part of the discipline in a unit, and the discipline of a unit can be gauged to a great extent by its sanitary standard and its sick rate. This is seen specially in the high sick rate usually found among " employed " men such as orderlies, storemen and others who do not live in barrack rooms and therefore escape supervision. It is seen also on active service where the incidence of sickness of a preventable type is highest amongst the less disciplined troops and followers.

Definitions

Hygiene is the science of the maintenance and promotion of health and the prevention of disease.

It is concerned largely with investigation of the causes and methods of spread of disease and the means of prevention. This entails much research work of a scientific nature and the rapid strides made in recent years have borne fruit in the reduction of preventable disease. Striking examples of the advances made are the prevention of such diseases as typhoid

and diphtheria by inoculation and the reduction of food deficiency diseases by vitamin-containing foods.

Hygiene is a progressive science which calls for continual investigation.

Sanitation is the practical application of the science of hygiene to the varied conditions of life.

The laws of hygiene are the same everywhere but the practical application of them, *i.e.* sanitation, varies with the local conditions under which they have to be applied, and the method of application will depend largely upon these conditions. It is a law of hygiene, for example, that a supply of water for drinking is necessary for health and life, but the method by which water is supplied varies from the rain-water barrel collecting water from the roof to the elaborate municipal systems made for the supply of water to the occupants of towns.

Conservancy is the collection, removal and disposal of waste products such as excreta and refuse.

It is, therefore, only a part, but a very important part, of sanitation, although there still exists in the minds of some people the idea that hygiene and sanitation are concerned solely with latrines and drains.

Cleanliness is closely associated with the preservation of health and the prevention of many diseases, but hygiene and sanitation include far more than cleanliness alone, for it is possible to have spotless cleanliness of person and surroundings and yet at the same time to have a considerable amount of preventable disease such as malaria, which is spread by mosquito bites, and undulant fever, which is spread by drinking the milk of infected goats.

The objective of sanitation

The aim of sanitation in the Army is military efficiency and therefore everything that will maintain or improve the health of the soldier and thereby aid his military efficiency must be regarded as coming within the scope of hygiene and sanitation.

The Medical Services help by instruction, advice, supervision and precept, but these are of little avail if the rest of the Army do not play their part. It is the duty, therefore, of every one to take his share in looking after, not only his own health, but also that of his comrades. The objective is twofold, first, to prevent actual disease, and, secondly, to promote and increase the health; these are by no means the same, for men may not actually be ill but may be in such a poor physical and mental state that when any extra strain is put upon them they break down. They may be compared with a second-rate football or cricket team which just succeeds in drawing games but never wins.

Causation of disease

Diseases affecting the Army may be divided broadly into two groups :—

1. Communicable diseases or those caused by living organisms or germs which invade the body.
2. Diseases not due to germs but to some condition which prevents the efficient working of the body.

Group I

Communicable diseases due to living organisms

1. *Excremental diseases.*

   Enteric fever, dysentery, diarrhœa, cholera, worm diseases. The germs pass out of the human body in the excreta and, by means of water, food or hands, they get into the mouth of a healthy man.

2. *Droplet infections.*

   Tonsillitis, influenza, diphtheria, cerebro-spinal meningitis and tuberculosis are the most usual, but there are other so-called infectious diseases such as mumps, whooping cough, scarlet fever and measles which may be spread in this way. Such diseases are spread by germs from the nose, throat or lungs, being sprayed out into the air in droplets of saliva during coughing, sneezing, spitting or even talking.

3. *Contact diseases.*

   Venereal diseases, skin diseases, scabies. There is usually actual bodily contact between two individuals, as during sexual intercourse.

4. *Insect- or animal-borne diseases, the commoner examples of which are :—*

   (a) Insects—

   Mosquitoes :—malaria, dengue, yellow fever, filariasis.
   Sandflies :—sandfly fever, kala-azar, leishmania infantum, tropical sore.
   Flies :—intestinal, excremental and worm diseases.
   Lice :—typhus, trench fever, skin infections.
   Fleas :—plague.
   Ticks :—relapsing fever, tropical typhus.

   (b) Animals.

   Dog :—rabies.
   Rats :—plague and spirochætal jaundice.
   Goat :—undulant fever.

The insect or animal concerned may act merely as a mechanical carrier of disease organisms, or as an intermediate

host in the body of which some stage in the development of the organism takes place.

Group II

Diseases not due to living organisms

1. Exposure.
   Heat and cold :—heat stroke, heat exhaustion, frost bite, trench foot.
2. Injury.
   Chafing from ill-fitting clothing or boots.
3. Improper food.
   Deficiency of quantity, quality or essential ingredients :—scurvy, beri beri, rickets.
4. Poisons.
   Inorganic :—lead, arsenic, etc.
   Organic :—tobacco and alcohol.

From this classification it will be seen that the majority of the diseases, especially those in Group I, are preventable if the correct methods of prevention are adopted ; these methods must be directed against the source of the disease and the route by which it is spread and towards the protection of the healthy man.

Special factors relating to disease in the Army

The soldier is in a somewhat different position from the civilian in relation to disease.

The military population consists of a large proportion of young men who have all been subjected to a thorough medical examination before entering the Army ; they live a disciplined communal life, which is under constant supervision, and under this system of supervision and discipline health measures can be adopted more rapidly and effectively than in a civilian community.

On the other hand the communal life of the soldier brings about closer contact between individuals and, therefore, greater opportunities for the transference of communicable diseases from one to another.

Garrison life in barracks most nearly resembles the life of the civilian in respect of housing, water supply and conservancy, and the individual soldier does not have to concern himself much with sanitary matters other than cleanliness while in barracks, but on active service diseases of all kinds become more prevalent for the following reasons :—

1. Men are crowded together more closely and germs of disease can be more easily spread from sick to healthy men.

2. Men are not so resistant to disease, because their vitality is lowered through exposure to fatigue, mental strain, less satisfactory feeding and to unaccustomed climates.
3. The military situation may make it necessary to occupy unhealthy sites which would otherwise be avoided.

The chief causes of sickness in an army in the field are excremental diseases, such as dysentery, enteric fever and diarrhœa, and insect-borne diseases, such as malaria and typhus fever, while serious losses may be caused by influenza cholera, cerebro-spinal meningitis, scurvy or plague.

In addition to these more important and sometimes fatal diseases there are many others which, although not fatal, may seriously reduce the strength of the Army in the field ; among the more important of these are the so-called " dirt diseases," such as scabies, boils, trench fever and inflammation of the skin.

Wherever troops live under adverse conditions of overcrowding, bad feeding, fatigue and unsatisfactory surroundings, the prevalence of disease increases. This applies not only to troops on active service but also to those living in barracks in peace time, and it is therefore essential that attention should be paid to all the details of the soldier's life, namely his surroundings, clothing, food, work, recreation and personal hygiene, or in other words his environment.

Literature.—All ranks are strongly recommended to read Health Memoranda for Soldiers (A.F. B 51), a copy of which is issued to each soldier on enlistment.

Married officers and soldiers and their families proceeding abroad are recommended to read Notes for the Preservation of the Health of Women and Children Proceeding to India and other Tropical Countries (A.F. B 51 A).

CHAPTER II

ENVIRONMENT

Environment may be defined as the surroundings or conditions influencing development and growth and, as far as the living body is concerned, its general health. The environment of the soldier includes everything in his daily life which may affect his health and thereby his military efficiency, such as climate, clothing, work, feeding, water supply and housing. Food, water and housing are so important that they will be dealt with separately in subsequent chapters.

The daily life of the soldier is very varied; part is spent under peace conditions at home in barracks with periods in training camps or on manœuvres, part is spent abroad under conditions of climate and surroundings which may be very trying to health, and part may be spent under active service conditions which are the most trying of all.

All these conditions under which the soldier serves must be studied and taken into consideration so that his environment may be modified to suit his mode of life, and to do this it is necessary to know first how the body lives and works and secondly how it is affected by environment.

The human body may be compared to the engine of a motor car in that it has to be supplied with food for fuel and with water, its temperature has to be regulated by a cooling system, and its waste products have to be removed. The body is, however, a much more complicated mechanism than any engine, because it has to carry out its own repairs and replacements while working, and also because its efficiency depends to a greater extent on its environment.

Fuel is taken into the body in the form of food and is burnt up to supply energy for keeping the body alive, and also for muscular work. This work produces a large amount of heat, some of which is used in keeping the body warm and the rest has to be got rid of; the more the muscular work done the more the food required and the more the heat produced. This heat is got rid of chiefly from the skin, but as sufficient heat cannot be eliminated from the dry skin during hard muscular work, sweat is poured out to wet the skin, and the evaporation of this sweat from the surface of the body produces the cooling effect.

When the body works under adverse conditions more heat is produced and, if this extra heat cannot be dissipated, fatigue sets in more rapidly and the effects of heat retention will be

felt. Such conditions may be brought about by unsuitable, heavy or tight clothing or equipment, hot climates, bad ventilation, ill-health or pain from such disabilities as sore feet.

In cold climates more of the heat derived from the food is used in keeping the body warm, therefore more food is required and the body has to be covered with warm clothing to prevent excessive loss of heat; on the other hand, in hot climates less food is required to keep the body warm and the clothing must be light and loose fitting to assist heat loss.

Clothing

Clothing is primarily intended for the protection of the body against cold, heat and injury; in addition, the clothing of the soldier must be uniform, economical and hard wearing, while for field service the outer clothing must be inconspicuous. The essential factors in deciding on the suitability of military clothing are materials, fitting and colour. A material with large air spaces is the most satisfactory in a cold or temperate climate because it keeps the body surrounded with air of an even temperature. Dry air is a poor conductor of heat, and clothing containing large air spaces keeps in the body heat in cold climates. For general purposes in cold and temperate climates woollen clothing is the best as it has the largest proportion of air spaces; woollen clothing, however, may be very irritating to sensitive skins, but this can be overcome by providing an inner surface of cotton or by including a proportion of cotton with the wool in the material as in the Army shirt which is 70 per cent. wool and 30 per cent. cotton. The use of a cellular mesh material for underwear also achieves the object of surrounding the body in an envelope of air at an even temperature. Retention of moisture in the material must also be considered both from the point of view of sweat and external moisture. Wool, except when in its natural state, absorbs water rapidly and gives it up slowly, so that, when wet with sweat or rain it soaks up the moisture quickly but dries slowly and thereby prevents chilling of the skin by rapid evaporation. Cotton and linen materials absorb moisture slowly but dry quickly and therefore may cause excessive moistness of the skin or too rapid cooling; nevertheless, during the heat of the day in the tropics they conduce to greater comfort than woollen clothing.

The colour of military uniforms must be inconspicuous and for this reason khaki is used. Grey or other neutral colours are also inconspicuous, but white is easily visible. The colour of clothing is important in hot climates from the point of view of coolness.

When a person is exposed to the sun, some of the heat rays are absorbed by his clothing and some are reflected. Dark

clothing is hotter because more heat is absorbed and less is reflected, whereas white clothing is cooler because less heat is absorbed and more reflected. Khaki colours are hot, but not so hot as dark colours.

In hot weather or when hard work is being done the evaporation of heat from the body can be assisted by having the neck, arms and knees bare, and by correct fitting of the clothing.

Clothing must be of a good fit, not only for the sake of appearance, but also to allow free movement of the chest, abdomen and limbs and to prevent chafing.

The proper fitting of boots is essential for good marching and should be carried out with the soldier wearing his full load. Socks should not be too big or too small; they must be kept in good repair and clean.

Sun helmets are required in hot countries to protect the head and nape of the neck from the sun's rays; the Army pattern is the Wolseley helmet, which can be improved by the Vero head band, which allows of free ventilation, and the Crowden aluminium foil lining, which reduces the temperature of the air inside the helmet.

Attention must be paid to the cleanliness of clothing. Underclothing soon becomes foul smelling from the accumulation of sweat and grease from the skin. When free circulation of air round the body is prevented, dirt and germs accumulate on the skin and give rise to sores and boils. Dirty clothing also becomes infested by vermin. Underclothing should be washed thoroughly once a week and parts of the outer clothing which come in contact with the skin should be cleaned frequently. Verminous clothing must be disinfected. Bedding and blankets require regular cleaning and exposure to the sun. Blankets are usually washed only once a year, but sheets and pillow slips should be washed at least once a fortnight. Clothing or bedding which has been used by a man suffering from infectious disease must be disinfected and must not be returned to store until this is done (King's Regulations, 1928, para. 1290). Equipment is considered in Chapter IX (Hygiene of the March).

Climate

Man is able to withstand diverse conditions of climate provided his mode of life is adapted to the particular climate. The body, however, takes time to adapt itself to the climate and it must be given every facility to become acclimatized and to adjust itself to the altered conditions. The climate of a country is determined largely by its temperature and rainfall, which are in turn dependent on many factors such as latitude, altitude, proximity to the sea and prevailing winds.

For instance, an island climate, such as that of Britain, is comparatively warm without extremes of heat and cold and has an even and not excessive annual rainfall; a continental climate, such as that of the N.W. Frontier of India, is dry with extremes of temperature. A tropical climate, such as that of South India, is found in the region of the Equator and is hot with heavy rain at seasonal periods.

Air is a necessity of life, as it contains, among other things, the oxygen which is used in the consumption or burning up of food taken into the body and thereby the production of body heat and energy.

The composition of air :—

Oxygen	20·95 per cent.
Nitrogen	78·07 ,, ,,
Carbon dioxide	·03 ,, ,,
Other gases	·95 ,, ,,

In addition it contains varying amounts of water vapour, and, in the vicinity of towns, impurities in the form of germs, dust, acids, etc.

Air is breathed into the lungs and the oxygen is taken up by the red cells of the blood; it is thus carried to all parts of the body and used up in the production of heat and energy and in supplying the requirements of the body. The blood, having given up its oxygen, takes up carbon dioxide gas and water which it discharges into the expired air on return to the lungs. The results of respiration then are the removal of oxygen from and the addition of carbon dioxide and moisture to the air.

During respiration dust from the air is breathed in and any harmful germs present in the dust may give rise to disease. During expiration droplets of saliva containing germs from the lungs, throat and nose are expelled into the air and these droplets are so light that they float about in the air and may be breathed in by other people and so infect them with disease. Coughing, sneezing and spitting increase the number of droplets sprayed into the air and therefore increase the possibility of infection. During ordinary breathing these droplets may travel two to five feet before falling to the ground, and shouting, coughing or sneezing extends the range up to 24 feet.

The water vapour or moisture in the air varies considerably. The air over the earth's surface is in constant movement and warm winds passing from hot countries across the sea become charged with moisture and, on coming in contact with cooler layers of air, deposit this moisture as rain or clouds.

Air that is rich in moisture prevents the passage of heat through it and therefore reduces the heat of the sun and the power of direct sunlight on the earth, thus equalizing the

temperature by night and day. Moisture in the air, or humidity, also checks evaporation from the skin, while dryness of the air causes excessive evaporation and drying of the skin with increased loss of water from the body and resultant thirst.

Excessive drying can be checked by increased consumption of water but excessive humidity is much harder to bear, as the increased production of sweat, which does not evaporate, leads to a sodden condition of the skin and prickly heat.

The moisture in the air, or humidity, is estimated by means of the wet and dry bulb thermometer or by finding the dew point, *i.e.* the temperature at which the air becomes saturated with moisture. Humidity is usually expressed as relative humidity, which is the ratio, expressed as a percentage, of the amount of moisture actually present in the air to that amount which would be present were the air saturated at that particular temperature.

Humidity depends on temperature, for, when the temperature of the air is raised, its power of absorbing moisture is increased and the percentage of moisture, *i.e.* the relative humidity is reduced. Then at nightfall the temperature of the air falls, the air becomes saturated with moisture and dew is formed.

When the temperature of the air is high and the humidity is high also, evaporation cannot take place, with the result that the temperature of the body rises and there is danger of heat stroke.

Man has almost incredible power of adapting himself to variations in the temperature of the air. Workers in foundries may be exposed to very high temperatures for short periods, while on Polar expeditions the temperature may be as low as $-75°$ F. The fact that man can maintain a constant body temperature under such variations of atmospheric temperature is due not only to the heat regulating mechanism of the body, but also to the regulation of the evaporation of heat from the surface of the body, which in turn depends on the condition of the air in contact with his body. The effect of atmospheric conditions upon the body depends on temperature, humidity and air movement; the chemical composition of the air is not such an important factor, although at one time it was thought that all ill effects were attributable to carbon dioxide gas and poisonous exhalations. The discomfort and harmful effects of a badly ventilated room result from interference with the dissipation of heat from the body, or, in other words, from a reduced cooling power of the air. An instrument called a katathermometer (*see* Appendix 2) is used for determining this cooling power.

For the efficient regulation of body heat when working indoors in a hot humid atmosphere it is necessary to reduce the temperature and humidity of the air in the room and to create a gentle air movement.

Beneficial effects are also obtained by wearing light loose-fitting clothes.

Work

Part of the food taken into the body supplies energy for muscular work and in so doing gives rise to heat. The amount of heat produced is increased if the body has to work under bad conditions such as fatigue, pain or lack of training. The trained man can convert into work 30 per cent. of the total energy values of the food absorbed, whereas the efficiency of the untrained man is only 20 to 25 per cent. : there is then still about 70 per cent. of the available energy to account for, and this is got rid of partly in the process of living, partly as waste products, but chiefly as heat. If this heat were not removed, the body would become overheated and damaged during severe muscular work. In addition to providing fresh oxygen and removing carbon dioxide, the blood in its circulation carries away the excess heat which is then got rid of in the air expired from the lungs, by the evaporation of sweat and by the urine.

The effect of muscular work is :—

1. Slight heating up of the body, which, as in the case of any other engine, works better when warmed up. The normal temperature of the body is between 97° and 99° F., but during work it is 100·5° F.
2. Increased rapidity of breathing to bring more oxygen to the lungs.
3. Increased rapidity of circulation of the blood to bring more oxygen to the muscles and to carry away heat and waste products.
4. Increased production of sweat to assist evaporation from the skin.

Inability on the part of the body to compete with work becomes apparent by excessive sweating, distress and fatigue, and these set in earlier in the untrained man than in the man whose muscles are trained to perform muscular work.

Rest

Rest is necessary to allow the muscles to recover from work and to refit themselves for further efforts. Rest is also necessary for the repair and replacement of worn parts of the remainder of the body such as the brain and digestive organs.

Cessation of work or change of occupation will give rest, but sleep is necessary for the relaxation of the whole body. The first two hours of sleep are the deepest and most refreshing, but a full-grown man requires seven hours, while the young growing recruit should have at least eight hours' sleep out of every twenty-four. Reduction in the hours of sleep, as by festive nights or by the hot stagnant air of the tropics, leads to inefficiency and incapacity for work. Many believe that it is necessary to rise early in the tropics so that the work of the day can be done in the cool of the morning; it has been pointed out already, however, that the human body, if fit, can resist high temperatures, and it is more important that the early morning hours, which are often cooler than the night, should be spent in sleep, as adequate sleep is more important than the possible danger of working in the heat of the day. Recreation and change of occupation are restful by preventing monotony in the daily life. Recreation for the mind is required as well as recreation for the body, and, where the soldier is provided with both, he is less likely to frequent undesirable places and run the risk of contracting venereal disease.

Personal hygiene

The daily round of life causes many impurities to be deposited on the surface of the body and these impurities must be removed if the body is to be kept healthy. The skin requires frequent cleansing not only to remove visible dirt, but also the salt, grease and dried sweat poured out from the glands of the skin, which otherwise will become clogged. Daily washing should be practised and special attention given to the armpits, crutch, between the buttocks, and the feet, especially between the toes. A hot bath should be taken at least once a week.

Cleanliness of the hands and finger nails is most necessary especially in persons handling food. The hands should always be washed after visits to the latrine and before meals.

The hair should be kept short all over the head and should be combed and brushed daily and washed frequently. Hair brushes and combs are often neglected and should be cleaned at least once a month. The teeth should be cleaned with a small soft brush twice a day or at least every evening after the last meal and should be inspected regularly for signs of decay. The use of a toothpick for the removal of food particles from between the teeth after meals is a practice to be recommended and is a wiser policy than that of rubbing away the teeth and gums with a hard brush and so favouring the entrance of germs. Dirty and decayed teeth accumulate germs and decaying matter and when germs are swallowed they poison the body and give rise to digestive diseases and rheumatism.

Diseases resulting directly from environment

. *Effects of heat*

Heat stroke is due to an autointoxication caused by retention of heat in the body owing to insufficient evaporation from the skin and to the accumulation of waste products from muscular fatigue under unsuitable conditions.

Sunstroke is a form of heat stroke due to the direct rays of the sun.

The conditions conducive to the onset of heat stroke are a hot moist stagnant atmosphere, tight heavy clothing, ill-health or any conditions which lower the vitality of the body such as constipation and alcoholic or sexual excess. Prevention is achieved by keeping the skin cool and clean, providing a free current of air by artificial ventilation, keeping the bowels open, supplying ample cold water for drinking, and avoiding over indulgence of any kind, while additional measures against sunstroke are the protection of the head and neck from the sun and of the eyes from the actinic or light rays by means of glare glasses.

Heat exhaustion is somewhat different. It is due to exhaustion of the heat regulating system by drainage of fluid from the body through prolonged sweating in the endeavour to keep down the body temperature to normal when the air is hot and loaded with moisture. It occurs among heavily laden soldiers on the march in hot weather, lorry drivers, stokers and others who work in hot moist atmospheres. Rest, cool fresh air and cooling drinks usually result in rapid revival.

2. *Effects of cold*

Frost bite is usually limited to the extremities such as the ears, nose, toes and fingers and is due to the slowing down and eventual stoppage of the circulation of the blood through these parts. Prevention consists in the protection of such parts and in stimulating the circulation.

Trench foot is due to a combination of cold, wet and restriction of the circulation, as by tight puttees and inactivity. It is a serious cause of loss of man power in trench warfare, but can be largely prevented by not wearing boots, socks or puttees which are tight fitting, and by keeping the feet warm and dry. Strict discipline should be maintained to ensure that such preventive measures are carried out.

3. The *effects of minor injuries* such as sore feet, chafing of clothing, scratching of sores, etc., are all minor complaints, but lead to military inefficiency. They can be prevented by education, inspection and discipline.

Diseases partially attributable to environment are very numerous; for instance droplet infections such as influenza and cerebro-spinal fever result from overcrowding; gastro-intestinal diseases result from insufficient care in the preparation, handling and storage of food, and skin diseases result from lack of attention to the cleanliness of the person and clothing.

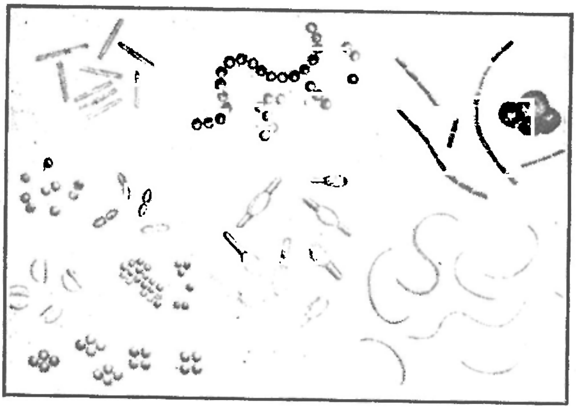

FIG. 1.—Examples of disease germs (bacteria) greatly magnified.

CHAPTER III

COMMUNICABLE DISEASES

The communicable diseases are those which are caused by living germs transmitted from one person or animal, either directly or indirectly, to another person or animal. They are sometimes called " contagious " or " infectious " diseases, but these are popular terms which are inaccurate, for, strictly speaking, a contagious disease is one which is only conveyed directly from one being to another, while an infectious disease is one that is conveyed indirectly. Epidemiology is the science of control and prevention of communicable disease. A disease is said to be epidemic when it spreads rapidly and attacks many people at the same time ; an endemic disease is one which is constantly present to a greater or less extent in any particular place, while sporadic cases of a disease are isolated cases which occur from time to time and are apparently unconnected with any epidemic.

Each communicable disease is caused by a distinct species of germ which can give rise to that particular disease alone ; for instance, the germ of typhus fever cannot give rise to typhoid fever and the germ of cholera can only cause cholera.

Germs belong to the lowest forms of life, either of the vegetable or animal kingdoms ; those of the vegetable kingdom are called bacteria, while those of the animal kingdom are called parasites.

Bacteria can be grouped according to their shapes, for example, bacilli are rod-shaped, cocci are round or oval, and vibrios are curved or comma shaped. They are all extremely small—eight thousand typhoid bacilli placed end to end would only measure one inch ; while some called viruses are so minute that they will pass through the pores of a fine porcelain filter and cannot be seen even with a microscope.

Under suitable conditions bacteria multiply very rapidly, and one bacillus may produce as many as seventeen million others in twenty-four hours. Most of the bacteria multiply by simply splitting into two new ones, but some form spores or seeds, which themselves develop into bacteria. These spores are surrounded with thick envelopes which make them very

resistant to heat, cold and drying, and therefore enable them to survive for long periods under conditions which would be fatal to ordinary bacteria and necessitate the employment of special measures for their destruction. Examples of spore bearing bacteria are those of anthrax, tetanus (lockjaw) and gas gangrene.

Parasites are more highly developed structures, and vary greatly in size and shape; they include the malaria parasites, amœbæ of dysentery, spirochætes of syphilis, and also certain worms which cause such diseases as schistosomiasis and ankylostomiasis.

All germs, like other plants and animals, are susceptible to environment and require food and suitable conditions of temperature and moisture for their growth and reproduction. They breed true to stock, *i.e.* each species remains distinct; a typhoid germ will only produce typhoid germs and malaria parasites will only produce other malaria parasites.

There are a very great number of different kinds of germs and many of them are harmless, while many work for the good of mankind by carrying out processes of nature such as nitrification of the soil to produce food for plants, ripening of cheese, raising of dough in bread, and even certain digestive processes in the human intestines.

The pathogenic or harmful germs are those which are capable of producing disease in man or animals under ordinary conditions. On getting into the body they destroy the tissues directly or by producing poisons, and the effect of such germs depends on their numbers and virulence and the susceptibility of their victim.

Three factors are necessary for the spread of communicable disease. There must be a *source* or reservoir from which the germs come, a *route* or routes by which they travel, and a *destination* in the body of a susceptible person. These three factors form the " link-cycle " of infection, and all preventive measures must be directed towards breaking these links.

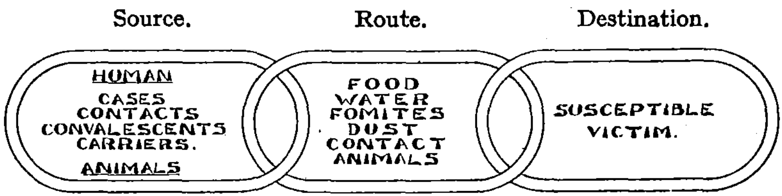

FIG. 2.—DIAGRAM.—Links in the chain of infection.

A good example of breaking the links is seen in the case of undulant (Malta) fever. The source of the disease is the goat which passes the germs in urine and milk. Other goats are infected by eating grass contaminated by infected urine, while man contracts the disease by drinking infected goats' milk. This disease was rife among troops in Malta until 1906, when the cause and route of infection were discovered, and as soon as the drinking of goats' milk was stopped there was an immediate fall in the number of cases of the disease.

The source of communicable disease is always another animal or person who is harbouring the germs. Man is the chief source of human infections, and he is usually a patient (case) suffering from the disease himself or is convalescent from the disease. He may, however, be a man who has been in contact with a case and may spread germs before he actually develops signs of disease.

Another source of infection is the "carrier." He is a man who has had a disease, such as typhoid or dysentery, and continues to pass the germs out of his body for some time after he has recovered; on the other hand he may never have shown any signs of the disease but may harbour the germs in his intestines, throat or elsewhere, and occasionally or continually discharge them in his excreta, or by coughing, sneezing, etc. Such carriers are dangerous sources of infection and have frequently been the cause of epidemics, especially of typhoid, dysentery, diphtheria and cerebro-spinal fever. It will be seen, therefore, that the human sources of infection are cases, convalescents, contacts and carriers.

Animal sources of disease germs are less important, but certain diseases may be contracted from animals, particularly the domesticated ones which come in contact with man; for instance, rabies may be contracted from the dog, glanders from the horse, plague from the rat and undulant (Malta) fever from the goat.

Germs of disease pass out of the human or animal sources of infection in fæces, urine, vomit, expectoration, milk, saliva, and blood or from the skin, while the bodies of men or animals that have died of a communicable disease are full of the germs and therefore dangerous. On leaving the source germs pass to other persons by various routes which may be direct, indirect, or through an intermediate host.

By far the most important are the direct routes of infection whereby fresh infective material is transferred from sick to healthy people. There may be actual contact between persons as in the case of diphtheria spread by kissing, and of venereal disease by sexual intercourse, or the contact may be more remote with a brief interval of time or space, as in what

is known as "droplet infection." The diseases spread by droplet infection are those of which the germs live in the nose, throat or lungs, such as influenza, cerebro-spinal fever and tuberculosis. These germs are sprayed out into the air in droplets of saliva during coughing, sneezing, spitting or

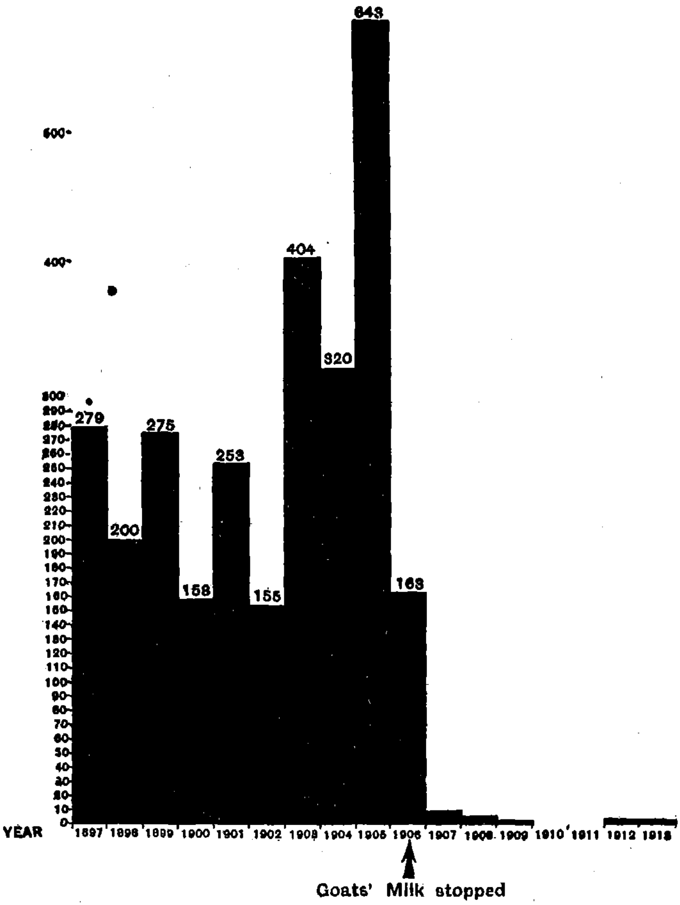

FIG. 3.—Chart showing undulant fever in Malta, and the effect of stopping goats' milk.

shouting, and these droplets float about in the air and are breathed in by other persons; they are also deposited in the saliva on cups, forks, spoons, etc., and may thus be conveyed to other persons unless such utensils are disinfected.

Germs of disease which have left the body may live for some time in such things as fomites, food, water, dust, soil, etc., and may survive long enough to be conveyed to healthy persons. These constitute the *indirect routes of infection.*

Fomites are any articles which are capable of absorbing or retaining infective material, such as blankets and bedding or clothing soiled by discharges from the body. Food and water may become infected if cooks or other persons handling articles of diet are "carriers," or if utensils are not thoroughly cleaned. Water supplies may be contaminated from latrines which are situated too close and from which the germs in fæces and urine soak into the soil and so reach the water.

At one time it was thought that infection could be carried by the air. It is not the air, however, that is infective but the germs in droplets and particles of dust carried by the air, which is only a vehicle. Dried excreta and expectoration form dust which may blow about in the air and be breathed in or contaminate food and water supplies.

Animals may act as carriers of disease germs. Rats which live in sewers and refuse heaps can carry filth and germs to human food; they can also carry plague by means of infected fleas which live on them and may be transferred to human beings. Flies are important agents in the spread of intestinal diseases such as typhoid, dysentery, cholera and diarrhœa, and especially in warm climates it is found that an increase in the number of flies is followed by outbreaks of these diseases.

Flies breed in excreta and refuse, and feed on sweet things, such as sugar, jam, milk, etc., so it is easy to understand how they can convey germs of diseases to human food unless the latter is protected from such contamination.

Lice are the agents by which typhus fever, relapsing fever and trench fever are transferred from sick to healthy persons, and *personal cleanliness is thus an important factor in the prevention of the spread of these diseases.*

Some insects may act as intermediate hosts for certain disease germs, *i.e.* the germs go through certain stages of their life in the bodies of the insect before they are transferred to man; for example, a mosquito sucks up malaria parasites in the blood from an infected person, the parasites go through certain stages of development in the mosquito and are then injected in the saliva of the mosquito into another person.

When the germs from the source of infection have been

carried by any of these routes to their destination, the susceptible victim, they enter the body by different channels of infection. They may enter by the mouth in food, water, or dust and be swallowed or inhaled: in certain diseases they may get through the broken skin in scratches or sores, while in others they may be inserted into the blood by insects such as mosquitoes, ticks, fleas or biting flies which have previously fed on diseased men or animals.

After they have invaded the body of their victim there is an incubation period before symptoms of the disease manifest themselves; during this the germs multiply and produce poisons. The length of this incubation period varies in different diseases; for example, in scarlet fever it may be as short as two days, while in typhoid fever it may extend to three weeks (*see* Appendix 3). Persons who have been contacts with a case of communicable disease must be kept under observation to see whether they show signs of developing the disease at the end of the incubation period; for example, contacts with a case of measles should be inspected daily from the seventh to the sixteenth day after exposure to infection. A person in robust health has the power to resist the attack of germs by means of certain constituents in his body, particularly in his blood, which render the germs harmless or destroy them. This power of resistance is reduced by conditions such as fatigue, exposure or starvation, which lower the vitality and allow the germs to gain the upper hand and produce disease. Germs may be present in the body and have no ill-effect until a lowering of the vitality of the body enables them to overcome the normal powers of resistance.

The healthy man may be protected against disease either by preventing the disease germs getting into his body or by increasing his powers of resistance so that, even if germs do gain entrance, his body is capable of overcoming and destroying them.

Examples of the prevention of access of germs are the use of nets against mosquitoes, the protection of food against flies by means of covers and meat safes, the purification of water supplies, the sterilization of eating and drinking utensils, and the use of rubber sheaths during sexual intercourse.

The powers of resistance of the body may be increased by attention to environment, sanitation, and general bodily and mental welfare, and also by conferring immunity by means of preventive inoculation.

Immunity is the power to resist disease and may be natural or acquired. Natural immunity is possessed by every one, but it varies in degree in different individuals and at different times in any one individual. Some persons have a natural immunity

from certain diseases and never contract them, while others may harbour germs and not develop the disease until their vitality is lowered by some cause or other. The effect of age on immunity is seen in the case of the diseases of childhood, such as measles and whooping cough, which do not often attack adults; similarly in the case of typhoid fever, immunity rapidly increases after the age of thirty. This factor of age in immunity is not, however, so much one of actual age; it is more likely due to the fact that a person is exposed to repeated small doses of germs and gradually acquires immunity as he grows older. Immunity may be acquired by an attack of a certain disease which protects against subsequent attacks of that disease. It may, however, be acquired as mentioned above by repeated doses of germs which are not sufficient to cause symptoms of the disease but are sufficient to increase the activity of the protective substances in the body. This form of acquired immunity is found in places where certain diseases such as typhoid are endemic, as in a native village in India; the typhoid germs may be widespread and yet the natives do not readily develop typhoid because they have been having repeated doses of the germs since childhood and their bodies have acquired protection. If, however, a person who has not lived under the same conditions, such as a soldier newly arrived from home, were to stay in such a place he would be very liable to develop the disease unless he had taken special precautions. The immunity which most people have against tuberculosis may be accounted for in the same way.

Epidemics may follow the introduction of a disease into a community where the disease has not existed previously, and where the inhabitants have not acquired immunity from that disease, as in the case of influenza among the Esquimaux. Similarly, when persons from isolated districts come to thickly populated towns, they are more liable to infection, as they have not the immunity which has been acquired by the townspeople; this was seen during the Great War when recruits from the outlying parts of the north of Scotland were ravaged with measles on arrival in towns in England.

Immunity may also be acquired artificially for certain lengths of time by preventive vaccination or inoculation against certain diseases such as small-pox, typhoid, cholera, plague and diphtheria. This artificial immunity by inoculation against a disease such as typhoid fever is carried out by injecting dead typhoid germs into the body. The protective white cells in the blood attack these germs which, although dead, contain certain poisons, or toxins, and to counteract these toxins the cells of the body produce antitoxins. These

antitoxins are produced in excess of the immediate requirements, and as long as they are available the body is protected against that particular disease.

All soldiers who have not suffered previously from small-pox have to be vaccinated or re-vaccinated on enlistment, and again every seven years at home, or every five years abroad, where there is increased risk of infection, but, if an epidemic occurs, the interval is reduced to two years.

They should also be inoculated against the typhoid group of fevers (T.A.B. inoculation) before proceeding abroad, and against cholera and plague whenever an outbreak is threatened.

All recruits and children should be tested for immunity from

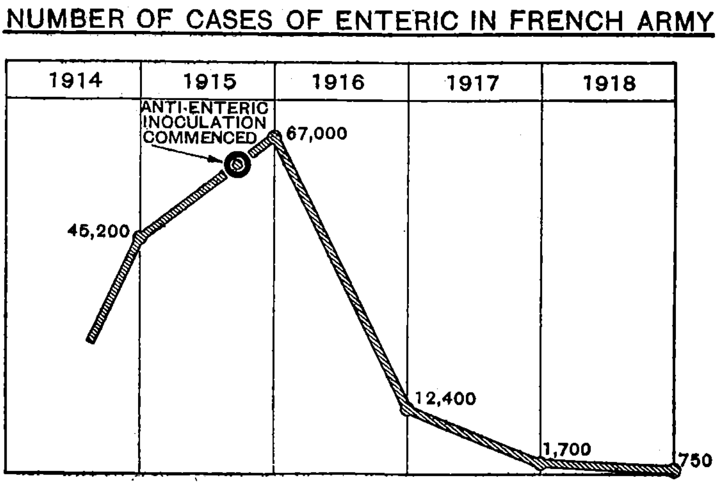

FIG. 4.—Enteric fever in the French Army.

diphtheria by means of the Schick test, and those who are not immune should be immunized.

In addition to the protection of healthy persons against communicable disease, preventive measures must be taken to break the links of infection between the source and the routes of infection.

Measures applicable to the source consist of isolation of the sick man; detection of mild cases; control of contacts, convalescents and carriers; and the destruction of animal sources of infection. Measures applicable to the routes of infection consist of prevention of contact between sick and healthy persons; disinfection of clothing, bedding, utensils,

excreta, etc.; prevention of overcrowding and provision of adequate ventilation; protection and purification of drinking water; cleanliness and protection of food supplies; and destruction of animal carriers.

Details regarding particular diseases and the preventive measures necessary against them are given in Chapter XII (*see also* Appendix 3).

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CHAPTER IV

WATER SUPPLIES

Water is one of the necessities of life but its need is often not realized until it is difficult to obtain. It forms more than a half of the human body and is constantly being got rid of in the breath, sweat, urine and fæces, so that a man loses three to five pints a day according to the amount of muscular work and sweating that he does; this loss must be replaced or damage will result to the body. In addition to the supply for drinking, water is required for cooking, washing and various domestic and industrial purposes.

Amounts

The amount of water required to be supplied daily for normal purposes is as follows :—

In barracks.

For each officer, man, woman, or horse	20 gallons.
For each child	10 ,,
For personnel and patients in military hospitals	50 gallons each person.

In camp.

For drinking and cooking only ..	1 gallon each person.
For all purposes	5 gallons ,, ,,
For a horse or camel	10 ,,
For a mule or ox	6–8 gallons.

These amounts have to be increased at stations abroad in hot climates and when troops are doing hard work.

Under certain conditions of high temperature and hard muscular work, as at blast furnaces or in stokeholds, a man may drink as much as five gallons of water a day.

Water requirements on the line of march are given in Chapter IX.

The original source of all water is the sea. The heat of the sun and warm winds passing over the sea cause evaporation with the formation of water vapour which, being lighter than air, rises and is carried by winds over the earth. On cooling, the water vapour condenses to form clouds and mists, which, when cooled still further, fall as rain, hail or snow.

When rain falls on the earth, it runs down on the surface in

streams or rivers and collects in hollows to form ponds and lakes. Artificial lakes or reservoirs may be made by damming a stream or blocking the end of a valley down which it flows, the area draining into such a reservoir being called a " catchment area." Water obtained from natural lakes in moorland districts or from reservoirs is known as " upland surface water."

Some of the water from the surface of the earth soaks into

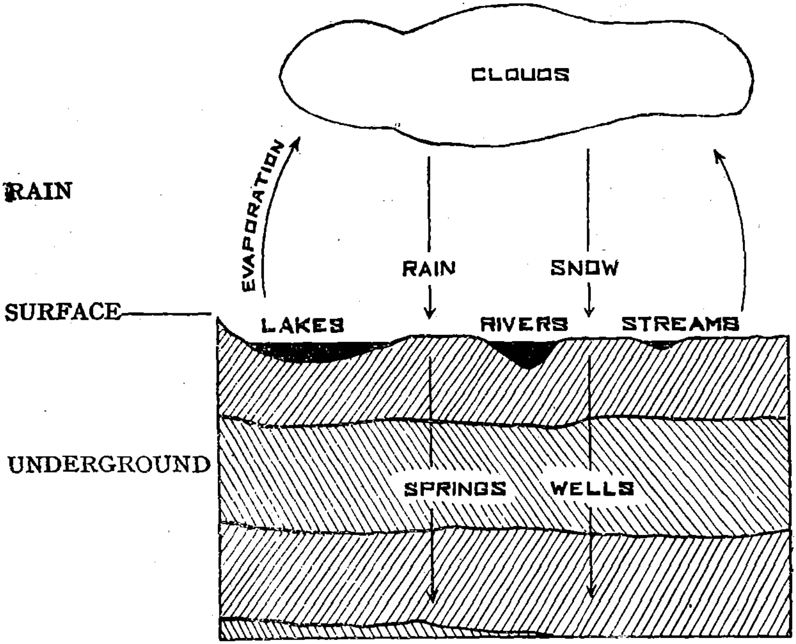


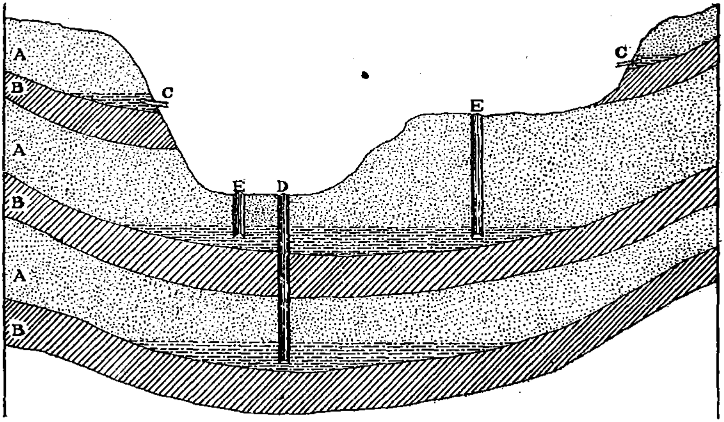
FIG. 5.—Sources of Water.

the ground to form underground water, and the depth to which it soaks will depend upon the formation of the earth below. The earth below the surface soil is composed of geological layers, or strata, of which some are composed of impermeable clay or rock, which will not allow water to pass through them, while others consist of chalk, sand or other permeable material, through which water soaks. Such strata usually run in slopes or may form folds with the result that

outcrops may be found where strata come to the surface of the earth, as on the sides of hills.

Water that has soaked through the soil percolates downwards until it reaches the first impermeable stratum and runs along its upper surface in an underground stream until it reaches an outcrop where it flows out on the surface as a surface or land spring.

It may be held up in a depression to form an underground lake or it may get through a fissure or crack and percolate downwards until it reaches another impermeable stratum.



A Permeable strata. B Impermeable strata.
C Springs. D Deep wells.
E Shallow wells.

FIG. 6.—Underground Water.
Showing springs, deep wells and shallow wells in relation to the permeable and impermeable strata of the earth.

Underground water lying above the first impermeable stratum is called "subsoil" water.

Underground water may be tapped by means of wells sunk into the earth. Shallow wells tap the subsoil water, while deep wells are those which are sunk below an impermeable stratum and tap the water lying on a deeper impermeable stratum. The classification of a well as shallow or deep depends on whether it taps the subsoil water or water below an impermeable stratum; a deep well may be comparatively short in length where the impermeable stratum is near the surface of the earth.

An artesian well is a form of deep well which taps water under pressure,.which therefore comes to the surface without pumping.

Tube wells consist of lengths of iron tubing fitted together and driven into the ground.

Deep springs deliver water from a deep water-bearing layer through a fault or fissure ; they may be heavily charged with gases or minerals and therefore are sometimes used for medicinal purposes.

Sources of water may therefore be summarized as rain, surface waters from streams, rivers, ponds, lakes and reservoirs, and underground waters from springs, shallow wells and deep wells.

Impurities in water

Impurities are found in all waters and are derived from the materials through which the water passes. Rain water is almost pure, but it picks up dust, soot, germs and acids during its passage through the air. Streams and rivers pick up further impurities from the earth and from sewage and industrial waste products discharged into them and may therefore be heavily contaminated ; similarly ponds and lakes may be contaminated by the impurities brought to them by streams and rivers or from the pollution of their banks. During its percolation into the ground water dissolves salts and other substances from the strata through which it passes, but at the same time it undergoes a process of filtration and suspended matter is removed ; water, therefore, from a depth may contain many chemical substances in solution but be free of suspended substances such as bacteria.

Impurities in water may be in solution or in suspension.

The impurities in solution consist of salts and chemicals which are dissolved in the water during its passage through the soil and, unless excessive in amount, they do not make the water unfit for drinking, although they may affect its uses for domestic or industrial purposes. Water that has passed through chalk dissolves salts of lime and, when considerable quantities of these salts are present in the water, it is said to be hard. Such water makes cooking difficult, especially the cooking of vegetables ; is wasteful of soap in washing and may clog boiler pipes by depositing the salts in them. Other salts found in solution in water are common salt in wells near the sea, lead from the corrosion of pipes by acid peaty waters, and iron. Chemicals may be added by an enemy in war to water supplies to make them poisonous or unfit for drinking.

The suspended impurities in water may be dead or living. Dead impurities may be decayed vegetable matter such as leaves and refuse, mineral substances such as mud, clay, fine

sand, etc., or animal matter from decaying carcasses or animal or human droppings. The dead impurities, like all foreign matter, if taken in drinking water, are apt to irritate the stomach and intestines causing indigestion, colic or diarrhœa; they also make it more difficult to remove living impurities from water by clogging filters or combining with chemicals and reducing their power of killing bacteria. Water containing much dead suspended matter is also muddy, unsightly and unpleasant to drink. The living suspended impurities consist of low forms of animal and vegetable life of which by far the most important are bacteria. Harmful bacteria such as those of typhoid, cholera and dysentery flourish in water which has been contaminated by the excreta of diseased men or carriers, consequently, as there is no indication from the appearance of water that it contains harmful germs, all water should be considered unsafe for drinking unless it has been treated and the germs removed or killed.

In addition to germs there may be found in water certain worms which cause disease.

Waters which are most likely to be contaminated with bacteria are those on or immediately below the surface of the earth, such as streams, rivers, ponds and shallow wells. The purity of water in streams and rivers varies greatly; houses or grazing grounds near their banks or draining into them are dangerous sources of contamination, and towns or villages situated on the banks pollute the water for many miles down stream.

There is less likelihood of pollution near the source of a stream, where the country is sparsely populated, or where the flow of water is rapid, as in mountainous districts.

Shallow wells are always liable to pollution by sewage which has soaked into the soil from neighbouring dwellings, and all surface waters must be considered to be contaminated and unsafe for drinking until they have been treated and the germs destroyed.

Water from the centre of large lakes or from midstream in big rivers is more likely to be pure as suspended matter will have had time to sink to the bottom.

Water from deep wells may contain salts in solution but is usually free of suspended matter, as it has been filtered during its passage through the earth. Such water is therefore usually pure.

Springs supply safe water if there are no dwellings nearby from which sewage soaks into the soil, and if the spring is properly protected from surface pollution.

Rain water freshly collected in clean receptacles is satisfactory as an emergency supply.

Sources of water in order of purity are :—

Artesian wells—deep borings.
Deep wells.
Springs.
Rain water.
Large lakes (centre).
Rivers (midstream).
Small streams.
Large lakes (near banks).
Shallow wells.
Rivers (near banks).
Ponds.

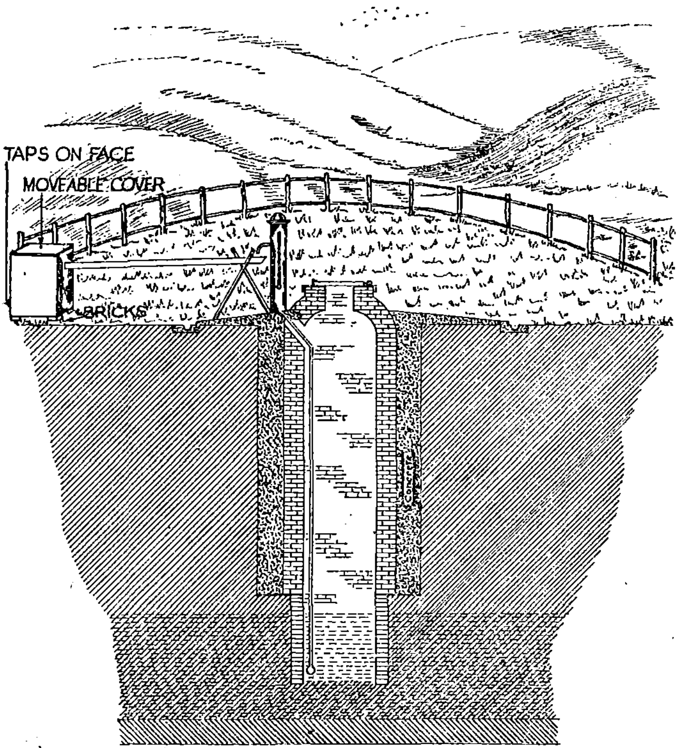
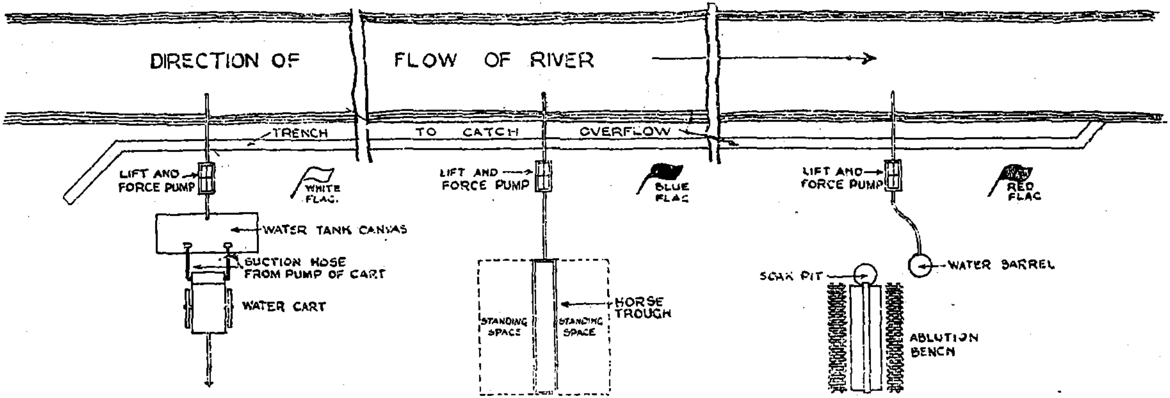


FIG. 7.—Protection of a well.

Water from any of these sources may, however, be polluted either at the source, in transport or during distribution, and



Space between flags not less than 100 yards.

FIG. 8.—Protection of water supply from a stream.

therefore it is necessary, especially on active service, to purify all water supplies and then safeguard them from subsequent pollution.

The protection of water sources from pollution varies according to the source. Catchment areas, consisting of large areas of ground, are protected from contamination by animals or human beings by being fenced in and by the prohibition of bathing in water within the area.

Wells are protected by being steined or lined with brick set in cement or other water-tight material and by carrying up the lining above ground level to form a coping. The well should be covered and enclosed within a boundary fence; the surface of the ground for a distance of six feet all round the well should be cemented and sloped away from the well. Water should be drawn off by a pump, which should deliver to covered distribution tanks situated just inside the boundary fence so that the final delivery is outside the fence.

Springs should be fenced in, and if necessary bricked in, and surface storm water should be diverted by means of a ditch dug round the spring.

Water from streams and lakes must be taken as far from the banks as possible and pumped into distribution tanks. Areas on the banks of streams should be allotted for drawing water for different purposes and indicated by coloured flags, white for drinking water, blue for watering animals, and red for ablution, in that order from upstream.

In addition all sources of water must be policed to prevent pollution and also to prevent men drinking water from unauthorized sources.

Purification of water in the field is a subject requiring careful attention as the importance of an adequate supply of safe drinking water for an army cannot be overestimated.

There are many methods of purification but they are all based on the principles of clarification to remove suspended matter followed by purification to destroy harmful germs.

Clarification

The different methods of clarifying water are by sedimentation and filtration.

Sedimentation consists of allowing the water to remain in reservoirs or tanks until the suspended impurities sink to the bottom as a sediment; this method is too slow for military purposes except for supplies for barracks and standing camps, but it can be hastened by the addition of chemicals, as is done in the canvas tank method, which will be described later.

Filtration consists of passing the water through clean materials such as sand or cloth, either by gravity or by means of a pump. Sand filters are used in large installations, such as

municipal supplies, and they were also made use of in the water sterilizing lorry during the Great War. The simplest form of sand filter is provided by a hole dug in sand some distance from a muddy river; the water from the river filters through the sand. Filtration through cloth is very efficient and its action is improved by the dirt deposited on the cloth; this method is used in the Elliott mobile water purifier and in the regimental water cart.

Sedimentation and filtration are greatly assisted by the use of chemicals, the chief of which are the salts of aluminium. Those most used are aluminium sulphate, and alumino-ferric; the latter is crude aluminium sulphate containing iron. When dissolved in water these aluminium salts form a loose transparent jelly consisting of aluminium hydrate, which entangles the suspended matter in the water and carries it to the bottom as a sediment. If the water is passed through a filter, such as a cloth, a film of jelly is formed on the cloth and increases the efficiency of the filter by holding back much finer particles than would the cloth alone.

Five to fifteen grains of alum are required for each gallon of water to be clarified and the effectiveness of the clarification depends on the water being alkaline. If the water is acid, as peaty waters are, or very hard, the jelly either forms very slowly or not at all; alkali in the form of soda is therefore added to the alum to make the water alkaline.

The methods of clarification employed for military water supplies in the field are sedimentation with alumino-ferric, clarification by filtration through cloth on which a gelatinous film has been formed by water clarifying powder, or by filtration through cloth only as in the Elliott mobile water purifier.

Sedimentation with alumino-ferric is carried out in the two-tank method in which the raw water is pumped into a canvas tank and alumino-ferric added; after standing in this tank for some hours to allow the sediment to settle at the bottom, the clarified water is syphoned off into another canvas tank at a lower level and there sterilized.

Water clarifying powder consists of two parts alum and one part sodium carbonate and is supplied in eight-ounce tins with a scoop holding 83 grains. It is used in the clarifying cylinders of the regimental water cart and in the Pack clarifiers, and in both the method of use is the same. Four scoops of the powder are placed between the mesh plates in the cylinder cover. The clarifying cloth is wrapped round the reel and placed in the cylinder, and the cylinder cover containing the powder is placed in position and screwed up. When water is pumped through the clarifying cylinder the alum is deposited as a fine film of jelly on the clarifying cloth, which thus filters

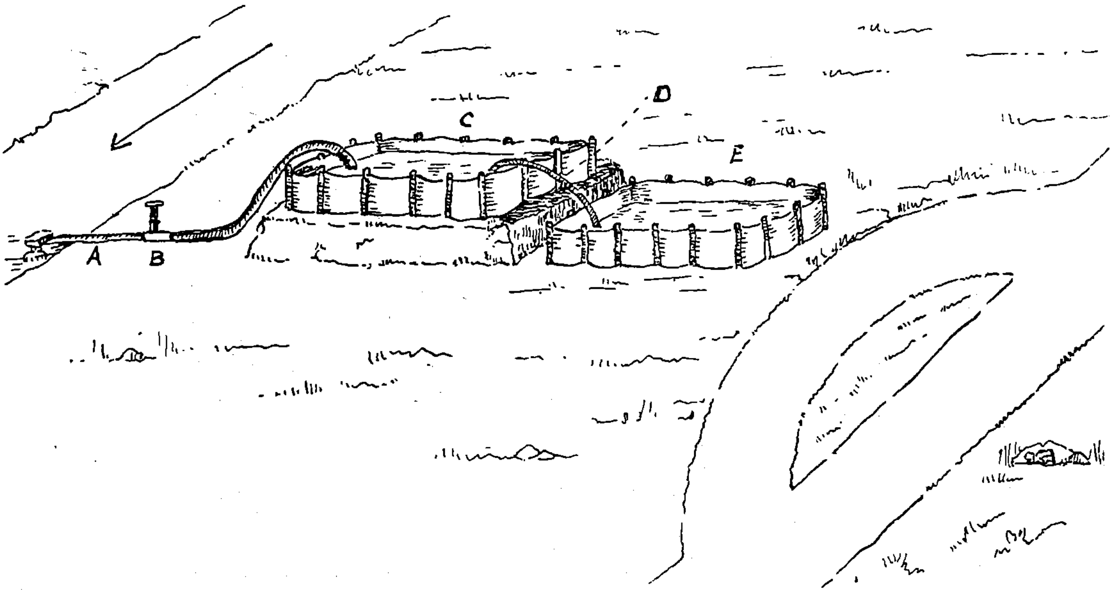


FIG. 9.—Two-tank method of purifying water.

Waterproof tanks of 2,300 gallons, actual capacity of each 1,500 gallons.

A.—Crude water suction pipe.
B.—Hand pump.
C.—Clarifying tank.
D.—Syphon pipe.
E.—Chlorinating tank.

NOTE.—Tanks to be covered with dustproof and rainproof covers.

all the suspended impurities, including many but not all of the living germs.

There are two clarifying cylinders on the regimental water cart and clarified water passes from each cylinder into the tank.

The Pack clarifier consists of one clarifying cylinder and a pump packed in a box for pack transport. When in use, the cylinder is clamped on to the lid of the box and the water is pumped through it into a tank or other receptacle.

Instructions for the use of the regimental water cart are given in Appendix 4, and a description of the Elliott mobile water purifier is given in Appendix 5.

Purification

Sterilization consists of killing all germs in the water. Some germs which are not harmful are very difficult to kill, but the disease germs are more easily destroyed and certain methods can be adopted which will produce a safe water without complete sterilization. The methods adopted for military purposes aim at producing a safe water as quickly as possible.

Boiling is the simplest and safest method of purification but is only satisfactory for small quantities on account of the difficulty and expense of providing fuel and the length of time taken to heat and then cool the water.

Filtration alone will not produce a safe water and the apparatus required is elaborate and expensive. Filtration through sand is used in large water works supplying towns or large camps. Small filters made of porcelain, charcoal or similar substances are sometimes used for domestic purposes, but they are slow in action and easily broken, and unless cleaned frequently they are a source of danger, as they soon fail to act.

Chemical methods are the most used and there are many substances employed for the purpose.

Potassium permanganate consists of purple crystals, which readily dissolve in water to form what is commonly called "Condy's Fluid" or "Pinkie Solution." It is used in a strength of one part in two thousand of clear water and is effective against cholera but is of little use against other disease germs.

Iodine consists of dark brown crystals, which are dissolved in spirit to form tincture of iodine. It can be used for purification of small quantities of water such as are required by single individuals; the taste, smell and colour of the iodine can be removed by adding small quantities of hyposulphite of soda (Hypo.).

Acids such as sulphuric and hydrochloric may be used for

the purification of small quantities of water, especially where cholera is prevalent. The best method is by the use of acid sodium sulphate, which forms sulphuric acid. It is issued in fifteen grain tablets and one tablet is added to every pint of water.

Chlorine is the chemical most used for water purification. At ordinary temperatures it is a gas which is very poisonous and rapidly kills all living matter. In very dilute solutions chlorine is not however harmful to man. It dissolves easily in water to form hypochlorite solution, which is also poisonous, and it is contained in several solid substances which readily give off their chlorine when added to water. Organic matter or dirt in water absorbs chlorine and lessens its action on germs and for this reason the water should be clarified first; it also has the disadvantage of giving the water a disagreeable smell and taste; these, however, pass off or can be removed.

Chlorine, therefore, can be used as a gas, or in liquids or solids from which it is set free. In the solid form it is available as bleaching powder, chlorosene and many other similar substances. Water sterilizing powder used in the regimental water cart consists of a mixture of four parts of bleaching powder and one part of quicklime and is supplied in four-ounce tins with a scoop capable of holding thirty grains of the powder; this powder should contain not less than 25 per cent. of chlorine and the amount to be used is determined by means of the Horrocks' test (see Appendix 4).

Chlorosene (super-tropical bleach, 30% available chlorine) is also used in the chlorine and chloramine treatment of water. It is more stable than bleaching powder and therefore more suitable for use in the tropics.

Automatic chlorinators may be used for bulk purification of water and the dosage of chlorine regulated by means of a chloroscope.

Ammonia chlorine process (chloramine).—Mixtures of ammonia and chlorine have properties differing from chlorine and the compounds produced are known as chloramines. Chloramine is a more powerful purifying agent than chlorine alone and, a matter of very great importance, it leaves a tasteless and safe water when properly used.

Chloramine possesses the further advantage over chlorine of not being deviated by organic matter, but, owing to its relatively slow powers of penetration, water should be clarified as well as chloraminated.

The dose of chloramine recommended to purify water in one hour is between one and two parts per million.

This method of purification, originally devised by Harold at the Army School of Hygiene, is used in the Elliott mobile

water purifier and in the Harold-McKibbin method for water carts and other water receptacles.

Water purification methods for military supplies in the field

The regimental water cart consists of a tank mounted on wheels and provided with two pumps and two clarifying cylinders; it has a working capacity of one hundred gallons and is capable of providing four hundred men with safe water in about one and a half hours.

Sterilization is carried out by means of water sterilizing powder (chlorine), the dosage of which is controlled by means of the Horrocks' test, or it may be done by the ammonia chlorine method. Full details are given in Appendix 6.

The ammonia chlorine method does away with the need for the Horrocks' test, the water has no unpleasant taste, is purified in one hour and remains pure for a longer time. Two tablets of ammonium chloride are crushed, dissolved in a cup of water, and added to the tank when it is two-thirds full of clarified water; two 30-grain scoops of chlorosene (thirty per cent. super-tropical chloride of lime) are then mixed in another cup of water and added to the water in the tank, which is then filled and allowed to stand for one hour. This method may be used for water receptacles of all sizes. Details are given in Appendix 6.

The Elliott mobile water purifier is an apparatus for purifying water in bulk. It has an output of 1,200 gallons an hour, but the water has to be stored for an hour before use. Purification is carried out by ammonia and electrolysed hypochlorite solutions followed by filtration through cloths. Details are given in Appendix 5.

The purification of small quantities of water may be carried out in various ways. Boiling is the simplest and the use of tea for drinking is to be encouraged as this ensures the use of boiling water. Tincture of iodine may be added in the proportion of two drops to the pint of water followed by sodium hyposulphite solution until the colour disappears. Acid sodium sulphate tablets, one to the pint, have been mentioned above, but the water must not be put in aluminium, white metal or German silver receptacles, which will be affected by the acid.

Water sterilizing powder (chlorine) may be used in the special water bottle method or in the black cup method.

Special water bottle method.—The Horrocks' test is carried out with clarified water and the required numbers of scoops of water sterilizing powder indicated by the test are mixed with a small amount of water and put into a water bottle kept specially for the purpose. This special bottle is filled with

water and well-shaken; one scoopful of the solution in the bottle is then placed in each man's water bottle, which is filled with water, shaken and allowed to stand for half an hour. The contents of the special water bottle will be sufficient to deal with the water bottles of 400 men.

Black cup method.—The Horrocks' test is carried out with clarified water, and the number of the first cup giving a blue colour multiplied by the number of the gallons to be purified gives the number of scoopfuls of the solution in the black cup to be added to the water, using the standard 30-grain scoop issued in the Horrocks' test case. For example, one scoopful of water sterilizing powder is made into a solution in the black cup and the Horrocks' test carried out. Supposing that the second white cup (No. 2) gives a blue colour and a pakhal containing 12 gallons of water is to be purified, then $2 \times 12 = 24$, which is the number of scoopfuls of the solution in the black cup which must be added to the 12 gallons of water in the pakhal. After the addition of the solution, the water must be shaken and allowed to stand for half an hour.

The ammonia chlorine method for small quantities is described in Appendix 6.

The selection of water supplies for camps is made by a staff officer in conjunction with an engineer and a medical officer; the supply is the responsibility of the Engineer Services, while the Medical Services supervise the collection, purification and distribution (see Field Service Regulations, Vol. I, 1930, Sec. 152).

The distribution of water in the field requires strict supervision and good discipline to ensure the use of safe water and to prevent its contamination. Water sources must be policed to prevent pollution and to ensure that men do not drink water from unauthorized sources. When separate supplies are used for drinking and cooking and for ablution purposes, they must be labelled distinctly "DRINKING WATER" or "NOT FOR DRINKING." If water is obtained from a stream, it must be pumped into tanks on the bank so that men and animals do not drink water direct from the stream, and also to prevent the pollution of water supplies of other units downstream. Horses should be watered downstream from the place where drinking water is drawn but above the sites for bathing and washing, and such sites should be marked by coloured flags as already described.

The most satisfactory method of distribution, which entails the least likelihood of pollution, is by means of water points. These may vary in size from one supplying a single unit to the larger central water points which supply all the units in an area. Water is drawn from the selected source, purified and

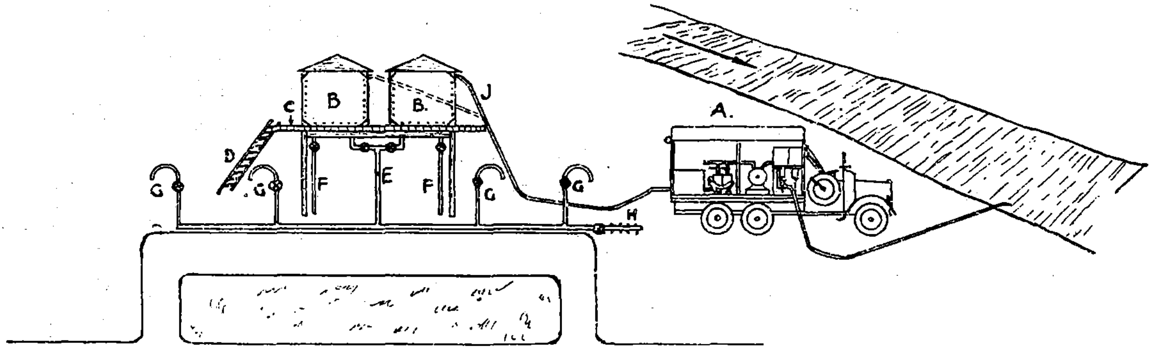


FIG. 10.—Water point.

A. Mobile water purifier.
B. Water tanks.
C. Platform.
D. Ladder.
E. Delivery pipes and valves.
F. Wash out pipes and valves.
G. Cart filling standards
H. Taps for filling utensils.
J. Connecting hose.

delivered into tanks at the water point, which should be situated on a subsidiary one-way road off a main road. The tanks must be provided with dust-proof covers and should be raised to such a height as to allow the water to be drawn off by gravity from the delivery taps, which should be so arranged as to provide facilities for filling water bottles and water carts.

Temporary water supply points.—With the introduction of power pumping plants into the equipment of Engineer field units for water supply purposes, small portable and rapidly erected tanks are necessary. A tank, waterproof, 1,500 gallons, is supplied for the purpose, but this takes some time to erect, as it is supported by pickets at the sides and corners, and a better type for the purpose is a circular canvas tank of a pattern similar to that sold for small swimming baths, such as the "Sportapool." Such a tank should be of a circular "Dutch cheese" shape made of sailcloth with a kapok float forming a narrow top opening supported and raised by the pressure of water in the tank; a canvas sleeve is provided at the bottom for emptying and another about half-way up for drawing off clarified water.

All water containers such as tanks and water carts should be cleaned regularly by being scrubbed out with a stiff brush and a strong solution of bleaching powder. Water bottles also require regular cleansing with boiling water or a strong solution of bleaching powder, and special attention should be paid to the scrubbing of corks or stoppers, which frequently collect dirt and become slimy.

Mineral waters.—Bottled aerated waters form a pleasant method of supplying drinking water but are very frequently polluted during the process of bottling, so that constant supervision must be exercised. The most likely sources of pollution are from workmen and from unclean bottles. Bottles with ball stoppers are more likely to become contaminated and bottles with "crown" corks are preferable.

Instructions for mineral water factories are given in Appendix 7.

Ice.—Disease germs are capable of surviving for some time in ice, which therefore may be a means of spread of diseases such as typhoid fever and cholera. In hot countries, ice is necessary for cooling drinking water and for preserving foodstuffs. Electric refrigerators are preferable to the old-fashioned ice boxes using blocks of ice. The practice of putting ice into drinks is dangerous and should be prohibited; water should be cooled by being placed in bottles on ice or in containers placed in a draught of air.

Water-borne diseases.—The diseases which may be spread

by water are the bacterial diseases, typhoid fever, paratyphoid fevers, cholera, dysentery, diarrhœa; also the worm diseases, schistosomiasis and ankylostomiasis. The germs of the bacterial diseases are passed out in the fæces or urine and may be deposited direct in water or reach it by soakage from drains or latrines or by other means. This polluted water must not be used for drinking nor for washing eating and drinking utensils. The germs of the bacterial diseases can live for some time in water, while part of the development of the parasites causing the worm diseases mentioned takes place in water before man is infected.

Water supplies contained in tanks, tins, etc., may be contaminated by dust and the containers should therefore always be provided with well-fitting lids. The lack of a sufficient supply of safe drinking water may cause serious outbreaks of disease. Only those who have suffered know the agony of thirst. Thirsty men will do anything in their power to obtain water, with the result that they may drink grossly contaminated water unless forcibly restrained. Strict water discipline, the policing of sources of water and the provision of an ample supply of safe water are therefore necessary for the prevention of water-borne diseases.

CHAPTER V

FOOD

The food taken into the body serves two purposes: it provides materials for the growth and repair of the tissues, which are continually being destroyed by the activities of life. It also supplies energy for doing work. These functions are performed by different components of the food, which therefore must all be present, for without them damage will result although there may not be actual starvation.

The body can exist for a certain length of time by using its stored reserves, but, when these are exhausted, death will occur rapidly unless a further supply of food is provided. In addition to having an adequate supply of food the body must be able to digest and absorb it, so it is necessary for the digestive system to be healthy and for the food to be supplied in an easily digestible form.

Digestion.—When food is eaten, it must be reduced to the form in which it can be used most easily by the body; in this process of digestion the food is acted on by various digestive juices and split up into substances which are then absorbed and carried all over the body by the blood. Digestion starts when food is chewed by the teeth and mixed with saliva in the mouth. When swallowed, it is acted on in the stomach by the acid gastric juice which is poured out from the stomach glands. The food is passed on from the stomach into the intestines, where digestion is continued and absorption takes place, and finally the waste matter, consisting of undigested substances such as fibres, vegetable cellulose, etc., are passed out of the large bowel. Digestion is assisted by a good appetite and by the food having an attractive appearance and smell, which stimulate the production of saliva in the mouth; hence the expression "making the mouth water." In the same way the flow of gastric juice is stimulated and digestion in the stomach assisted. Soup makes a good beginning to a meal because it stimulates the flow of gastric juices. The practice of drinking much liquid with meals hinders digestion by diluting the gastric juices, but some authorities advocate the consumption during meals of small quantities of water as an aid to digestion. The inclusion in the diet of a certain amount of vegetable foods aids digestion by giving bulk to the food, and thus increasing the muscular action of the intestines.

Composition of food.—The constituents of food required by the human body are proteins, fats, carbohydrates, mineral salts, vitamins and water.

Proteins are required for growth and to rebuild the tissues which are being continually worn out in the process of living. They are contained in both animal and vegetable foods such as milk, eggs, meat, fish, cereals and root vegetables, and are absorbed chiefly from the intestines in the form of amino-acids, which supply the nitrogen required for the body.

100 grammes of protein, of which 50 grammes should be first-class protein, are required daily by a man doing ordinary work.

First-class protein is obtained from animal sources such as meat, fish, eggs and milk, and can be used with less waste than vegetable proteins.

Fat is a source of energy, but it is not so readily digested and absorbed nor does it make its energy available so readily as does carbohydrate. Fats are contained to a greater or less extent in many articles of food but chiefly in meat, milk, fish and animal and vegetable oils. Any fat taken in excess of the immediate requirements of the body is stored as fat and forms a reserve supply which can be drawn upon when the normal supply of fats or carbohydrates is deficient. In temperate climates fats must not comprise more than 25 per cent. of the total diet, or indigestion will result ; on the other hand, a certain amount of fat is necessary for health and 100 grammes is the amount generally accepted as sufficient for the average man in a temperate climate, and of this as much as possible should be derived from animal sources.

Carbohydrates (starch and sugar) form the principal source of energy and are contained mostly in articles of vegetable origin such as bread, cereals, potatoes and other vegetables. They are absorbed as sugar, which is carried to the liver and there converted into glycogen ; this glycogen is then distributed by the blood to the body, chiefly the muscles, as required, and any excess can be stored as fat. An average man requires 500 grammes daily.

Mineral salts are essential for the life of the cells of the body and for its fluids. The most important salts required are calcium (lime), which forms part of the structure of the bones and teeth ; iron, which enters into the composition of the red blood cells ; iodine, as a preventive against goitre ; sodium, potassium, magnesium, phosphorus, sulphur and chlorine. Most of these salts are contained in an average mixed diet.

Vitamins are substances which are essential to growth and health, but little is known of their composition or how they act ; their absence from the food, however, gives rise to disease.

Vitamin A is essential for growth and nutrition and also protects against infection, while its absence gives rise to a condition of the eyes called xerophthalmia. Vitamin A is widely distributed in nature and is contained in milk, butter, cheese, yellow fruits, green leaf vegetables and yellow root vegetables, liver, fish oils and most animal fats, but is lacking in vegetable oils.

Vitamin B is made up of several factors of which two are particularly important.

The antineuritic factor, B. 1, is abundant in yeast, but is also present in varying amounts in most natural foods, particularly the edible pulses, such as lentils and peas, and the husk and germ of cereals, such as wheat and rice; it is therefore absent in polished rice, with which the disease beri-beri, a nerve disease, is especially associated.

The other factor, B. 2, is not so widely distributed but is present in yeast, meat, liver and white of egg; it is associated with growth and the prevention of pellagra, a disease in which the skin is affected.

Vitamin C is antiscorbutic, that is to say, it prevents scurvy. It is contained in fresh fruits, especially the citrus fruits—oranges, lemons and grape fruit; green leaf vegetables; tomatoes and radishes. Preserved lime juice contains little, if any, but lemon juice contains large amounts.

Vitamin D is necessary for growth, but is concerned chiefly in controlling the deposits of calcium and phosphorus, especially in the bones and teeth; it is therefore the antirachitic vitamin and prevents rickets and defective teeth. The only natural products which are rich in Vitamin D are egg yolk and fish liver oils, such as cod liver oil. Milk, cream and butter contain appreciable quantities if obtained from cows which have fed in the sunlight on good pastures. Animal fats such as suet and dripping contain small amounts, but vegetable fats, such as margarine, contain none. Vitamin E assists the powers of reproduction and prevents sterility. It is present in fresh green lettuce, wheat, oatmeal, meat, butter and vegetable oils.

Heat destroys vitamins, especially Vitamin C. Boiling for half an hour destroys all the Vitamin C in vegetables, and the practice of adding soda to preserve the colour of the vegetables hastens this destruction. Prolonged boiling also destroys the other vitamins. Canning reduces the vitamin content of foods, except tomatoes, which retain their Vitamin C, and therefore are valuable as an addition to the diet when fresh fruit or vegetables are not available.

Many of the foods which contain vitamins also contain mineral salts; for example, green vegetables contain Vitamins

A and B as well as iron and calcium; oatmeal contains Vitamins A and E, and also phosphorus; and eggs contain Vitamins A and D and iron. Such foods are therefore called the protective foods, and consist mostly of dairy products (milk, butter, cheese and eggs), green vegetables (especially salads) and fish.

Energy value of food.—The conversion of food into energy for work is accompanied by the production of heat and the amount of heat produced is, therefore, used to estimate the energy value of different foods. The standard unit for measuring the energy of food is the large Kalorie; this is the amount of heat required to raise one kilogramme of water one degree centigrade.

Energy is obtained from proteins, carbohydrates and fats, of which the energy values are approximately :—

proteins, 4·1 Kalories per gramme.
carbohydrates, 4·1 Kalories per gramme.
fats, 9·3 Kalories per gramme.

A full-grown man requires approximately 1,700 Kalories a day for the work of keeping the body alive while at rest; in addition, he requires another 1,300 Kalories a day while doing ordinary routine work, and 1,800 to 2,000 when doing hard work or undergoing exertion, as on the line of march. This means that approximately 3,000 Kalories must be provided daily in the food for the trained soldier doing ordinary routine work in peace time. An extra allowance, however, must be made for the young growing recruit under training and for the soldier doing hard work, and for these the daily amount of food should be increased to provide 3,500 Kalories or more. It has already been stated that the body requires 50 grammes of protein daily for body building; this 50 grammes will, therefore, give 205 Kalories and the remaining 2,795 Kalories can be made up with additional proteins and also carbohydrates and fats. Provided that sufficient minerals, vitamins and proteins are included, the remaining Kalories can be made up according to requirements. An average diet may be taken to consist of :—

proteins, 100 grammes	= 410	Kalories.
fats, 100 grammes	= 930	,,
carbohydrates, 500 grammes	= 2,050	,,
Total	3,390	,,

and, deducting 10 per cent. for loss in preparation and cooking, this will give 3,051 Kalories.

The Kalorie value of the army peace-time ration before deduction of 10 per cent. for wastage is approximately 3,600

Kalories while the war-time ration of front line troops in the Great War yielded approximately 4,200 Kalories.

(N.B.—28·4 grammes=1 ounce.)

Army rations.—Private individuals can select their own food according to their personal tastes and the amount of money they have to spend, but a military ration must be selected so

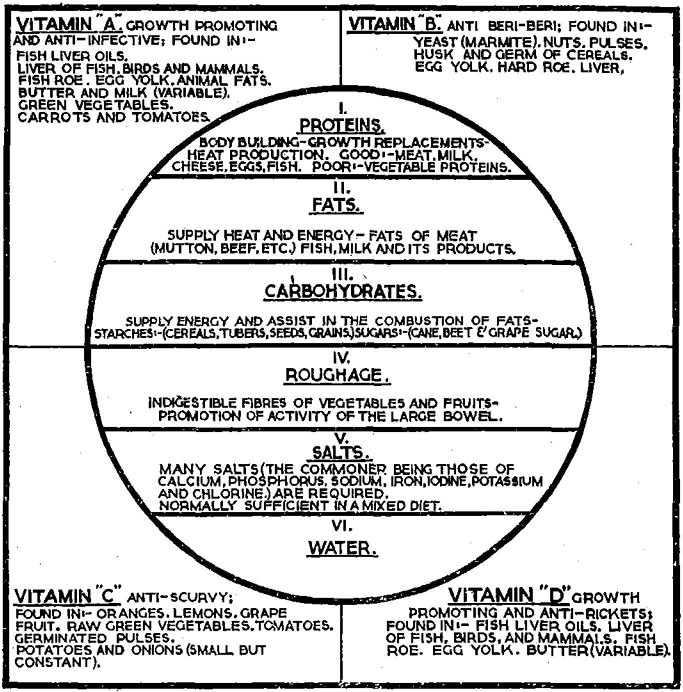


FIG. 11.—A square meal.

Adapted from the diagram of "A Square Meal" from "Food, Health, Vitamins," by R. H. A. and V. G. Plimmer, by permission of the publishers, Messrs. Longmans, Green & Co., Ltd.

as to supply most economically all the requirements of large numbers of men living the same life and doing the same work. In the case of active operations in the field a special scale of rations, dependent on climate and the special circumstances of the expedition, is fixed, and contains everything such as meat,

bread, vegetables, milk, groceries, condiments, etc.; in addition, the soldier is supplied with an "emergency ration," which he always carries with him for use when cut off from supplies.

In peace time part of the ration may be commuted for cash and part is replaced by a cash allowance. The money derived from these sources enables units to provide variation in the diet according to individual taste; this cash can only be spent on essentials and not on luxuries.

A well-balanced diet must contain the essential ingredients, namely, minerals, vitamins, proteins, fats and carbohydrates, and also be of sufficient bulk not only to give a satisfactory feeling of fullness after the meal, but also to provide "roughage" to increase the action of the intestines.

No matter how correctly the ingredients are balanced, the food must appeal to the appetite, and this entails variety, careful preparation, a pleasant appearance and smell, and good service in pleasant surroundings.

Cooking improves the appearance and smell of food and also kills harmful germs; it also breaks up the cellulose and wood fibres in vegetables and makes hard substances easier to chew. It increases the digestibility of vegetable, but not of animal foods, so that the object to be aimed at in cooking meat should be only to remove the raw appearance and to make it soft. Much of the food value may be lost by careless or bad cooking, and variety in cooking is as important as variety in the food. Vitamins are destroyed by prolonged heat and a continual diet of stews and overcooked food will result in a deficiency of vitamins.

The attractiveness of well-prepared food can be spoilt if it is not well served in pleasant surroundings. Separate dining-rooms or tents should be situated near the kitchen, and men should not be allowed to feed in their barrack rooms or tents. Dining-rooms, messes and institutes should be clean, attractive, well-lit and well-ventilated, and attention should be paid to the layout of tables. During the hot weather in the tropics, the principal meal of the day should be given in the evening instead of in the middle of the day, when men are little inclined for food, however appetizing it is.

Hot food should be kept hot until served by means of hot cases or hot plates. Hot cases and hot boxes are of great value in camp and on active service for providing hot meals for troops in trenches or for mobile troops who are split up into many small detachments. Foods which can be cooked by boiling can be brought to the boil on fires in a central kitchen and then placed in the hot box and dispatched to the troops. The process of cooking goes on in the hot box, and the food remains hot for a considerable time.

Alcohol must be looked upon as a luxury and not a necessity. Actually it is a poison and has a depressing action on the body; although it causes a momentary stimulation at first, this is followed rapidly by a reaction with diminished mental alertness, speed, and accuracy of movements requiring skill. Alcohol in small quantities has a definite value as a food, but the most that the body can make use of is one and a half ounces a day; any amount in excess of this acts as a poison and is excreted by the kidneys. Beer in moderation is

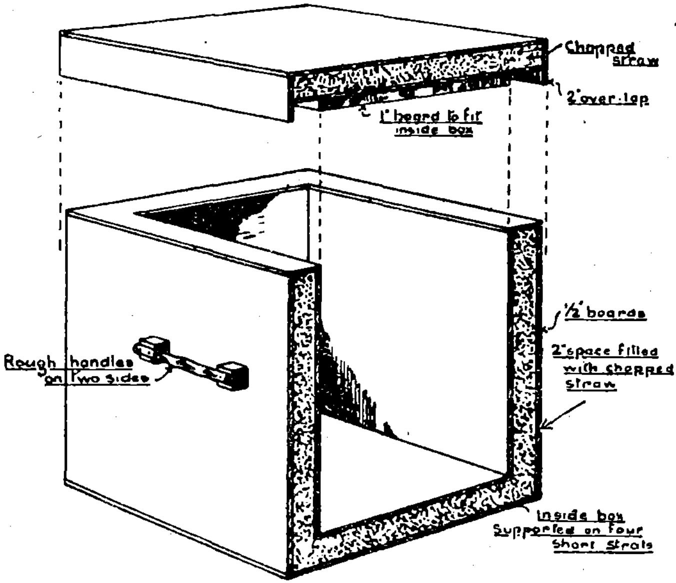


FIG. 12.—Jacketed hot box. One end removed to show construction.

fattening, but, when taken continually in excess, it has the same harmful effects as other stronger alcoholic liquors. Alcohol in excess has a bad effect on bodily fitness, especially in tropical countries, where it is one of the chief causes of heat-stroke. There is no justification for the belief of some people that the drinking of alcohol will kill germs in the body.

The greatest benefit derived from alcohol is due to its psychological effect, whereby it produces a feeling of comfort, warmth and well-being. This psychological effect is greatest when alcohol is given at the end of the day, especially when men are tired, cold or wet; it should be taken with or after a meal,

preferably just before turning in for the night, never on an empty stomach, and never before going out of doors in cold weather. At present rum is issued as part of the active service ration on the recommendation of a medical officer.

Tea made with boiling water and freshly infused is a good way of supplying safe drinking water. When sweetened it acts as a stimulant, and is a rapid restorative for tired men at the end of a day's march. Strong stewed tea is bad for the digestion, while the habit of young soldiers of drinking sweet tea and eating sweet buns and cakes before their midday meal should be discouraged, as it spoils their appetite for their principal meal.

Tobacco is not a food, but when smoked in moderation by grown men, it is comforting, especially when they are on short rations. Used in excess, especially by young growing men, it has a bad effect and causes irregular action of the heart, eye trouble and poor muscular condition. The smoking of large numbers of cigarettes, the inhaling of the smoke, and the use of strong tobacco result in disturbance of the heart's action, while the chewing of tobacco has a more powerful effect and also leads to the objectionable habit of spitting. Men should not use one another's pipes, as diseases such as syphilis are spread in this way. Boys should be forbidden to smoke.

Food diseases and their prevention

Diseases due to food may result from deficiencies of the essential ingredients in the food or from germs or poisons conveyed to the food.

1. *Deficiency Diseases*

Vitamins.—An insufficient supply of vitamins in the food results in a general loss of physical fitness and inability to resist infection. In addition, there are certain diseases which are due to a deficiency of some particular vitamin ; Vitamin A deficiency causes an eye condition called xerophthalmia ; Vitamin B deficiency causes beri-beri or pellagra ; Vitamin C deficiency causes scurvy, while deficiency of Vitamin D gives rise to rickets and defective teeth. Scurvy and beri-beri are the two diseases of military importance ; the former can be prevented by a supply of fresh fruit and vegetables and the latter by cereals and legumes, but unfortunately these may be difficult to obtain when they are needed most, for example, on active service in a tropical country or in a besieged garrison. In an emergency, fresh fruit and vegetables can be replaced by canned tomatoes and germinated peas and the

cereals and legumes by marmite. The method of using germinated pulses is given in Appendix 9.

Salts.—Deficiency in the mineral salts in the body may be caused by excessive sweating, which will result in salt starvation, as it did among the troops besieged in Kut during the Great War.

2. *Diseases conveyed by food*

Poisons such as arsenic, lead, copper, etc., may be present in food as a result of the treatment of raw foods with preservatives, accidental contamination as with rat poisons, or bad methods in canning.

Worms.—Some tape worms pass a stage of their development in the form of cysts embedded in the flesh of animals. These cysts are not destroyed unless the meat is cooked thoroughly so that, when raw or insufficiently cooked meat is eaten, the cysts develop into full-grown worms in the human intestine. Pigs are very frequently infected, and the supply of pork, bacon or ham to troops must, therefore, be supervised carefully.

Germs are the most common cause of diseases conveyed by food, and especially of tuberculosis, scarlet fever, diphtheria, typhoid fever, paratyphoid fever, dysentery, diarrhœa, cholera, undulant fever and the food poisoning group.

The germs may be contained in meat or milk from diseased animals such as tubercular cows, or they may be conveyed to food by flies, dust and contaminated water used for washing utensils, vegetables or other articles, or by the hands of persons, especially carriers of typhoid and dysentery, who, by their dirty habits, infect their hands with their own excreta and fail to wash them before handling food. Food from native bazaars is usually heavily contaminated, as it is exposed to dirt, dust and flies: fruit from such places is particularly dangerous, therefore only fruit which can be peeled, such as bananas and oranges, should be eaten uncooked. Vegetables, such as lettuces, which are grown on the ground in tropical countries are unsafe on account of the practice of manuring them with human sewage; such vegetables should not be eaten uncooked.

Unsound or decomposing food, especially meat pastes, sausages and fish, contain germs and may give rise to serious outbreaks of food poisoning, particularly in hot weather when food decomposes rapidly.

Canned food is usually safe and remains sound for a long time provided the tins are not opened. It is convenient for transport and storage, but a diet of canned food is monotonous

and lacking in vitamins. Tins which are "blown," rusted or badly dented should be condemned as these conditions indicate that the food is decomposed or that the tin sooner or later will cease to be airtight, and then the contents will become contaminated from outside.

Milk is one of the best human foods, but unfortunately it is also one of the most dangerous, as it may not only come from diseased animals, but it also forms an excellent food for germs and is attractive to flies. In hot countries and on active service, fresh milk is so liable to contamination and the difficulties of its transport and storage are so great that the use of condensed milk or dried milk powders is preferable. Dried milk can be reconverted into liquid milk by means of the "iron cow," which is a machine into which dried milk, butter, and water are placed and which then delivers what is, to all intents and purposes, fresh milk.

The process of pasteurizing milk kills the germs of such diseases as diphtheria, tuberculosis, undulant fever, scarlet fever and typhoid fever without destroying the food value, and is therefore recommended for all milk supplied to troops and their families. This process consists of keeping the milk at a temperature of not less than 145° F., and not more than 150° F. for half an hour and then cooling it *rapidly* to not more than 55° F.

In tropical countries, fresh milk is so liable to pollution that, if it is used, it should first be boiled; boiling, however, reduces its nutritive value and makes it unsuitable for young children, and so the use of dried milk is better. The practice of adulterating milk with possibly contaminated water, especially by native dealers and servants, should be guarded against. Cans, bottles and other receptacles for milk should be sterilized by steam and should be provided with dust-proof covers of a pattern which can be sealed to prevent them being tampered with. When open, receptacles should be kept in flyproof safes or be covered with gauze or other material to keep away flies.

The prevention of the contamination of food by germs can only be assured by rigid sanitary measures, including careful inspection of food supplies, scrupulous cleanliness and protection of the food from the time it is first issued until it is finally consumed.

Cleanliness must be observed by all persons handling food, and in all places where food is stored, prepared and served, such as larders, preparation rooms, kitchens, dining rooms, messes and institutes. Particular attention to cleanliness, especially of their hands and clothing, must be observed by cooks and others employed in the preparation, cooking or handling of food, and they must on no account continue at

their duties if suffering from diarrhœa, however slight, or other illness. No one who has suffered from, or is a carrier of, typhoid fever, paratyphoid fever or dysentery, or is suffering from or under treatment for venereal disease, may be employed in the preparation, cooking or handling of food. Cookhouses should be kept clean and free from flies, and all tables, cutting-up boards, chopping blocks and cooking utensils must be cleaned thoroughly after use. The practice of cleaning utensils with

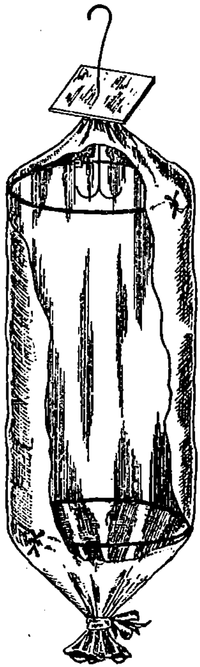


FIG. 13.—Improvised fly-proof larder.

earth or sand is very dangerous, and ashes from the fire should be provided for this purpose. Suggested sanitary rules for cookhouses are given in Appendix 8.

Satisfactory arrangements must be made for washing up after meals, and a plentiful supply of hot water, soap, soda and cloths should be provided. Arrangements must also be made for the disposal of dirty water, swill and kitchen refuse, since neglect of proper sanitation in these matters produces in-

sanitary conditions and attracts flies; such arrangements should be included in the training of cooks.

Canteens and institutes must be kept under sanitary supervision, and in foreign stations, civilian cafés and restaurants which will not comply with the sanitary regulations of the military authorities should be placed out of bounds to the troops.

The presence of hawkers in barracks, especially abroad, is undesirable and, if allowed, they should be licensed, and they, their premises and the foodstuffs they sell should be subject to regular medical inspection.

In foreign stations, the presence of native employees in barracks is always a source of danger of infection; their numbers should be limited and particular attention paid to their health, habits and dwellings.

Food should never be kept in rooms or tents where men live or sleep, near latrines, or anywhere exposed to flies.

The storage of food is not, as a rule, difficult in barracks where ventilated fly-proof and rat-proof stores and larders are provided, but in camp and on active service these may have to be improvised. Such improvised food safes should be made of wire gauze, muslin or similar material supported on frames; they must cover the food completely and be of sufficient size for the food to be placed inside without touching the sides, so that flies crawling on the outside cannot touch the food. Laying muslin or similar covers directly on to food is useless, as flies can still gain access to the food through the parts of the cover in contact with it. Temporary portable food safes can be made in box form to fold flat, while another simple but effective pattern can be made with wire rings surrounded with muslin as shown in Fig. 13.

Permanent safes should be made of seasoned wood and perforated metal or wire gauze, well-jointed and with close-fitting doors; they should provide free cross-ventilation and allow easy access for cleaning the inside, and should be kept clean and in good repair.

Food-safes should be used only for the storage of food; toilet articles, clothing and personal property must never be put into them.

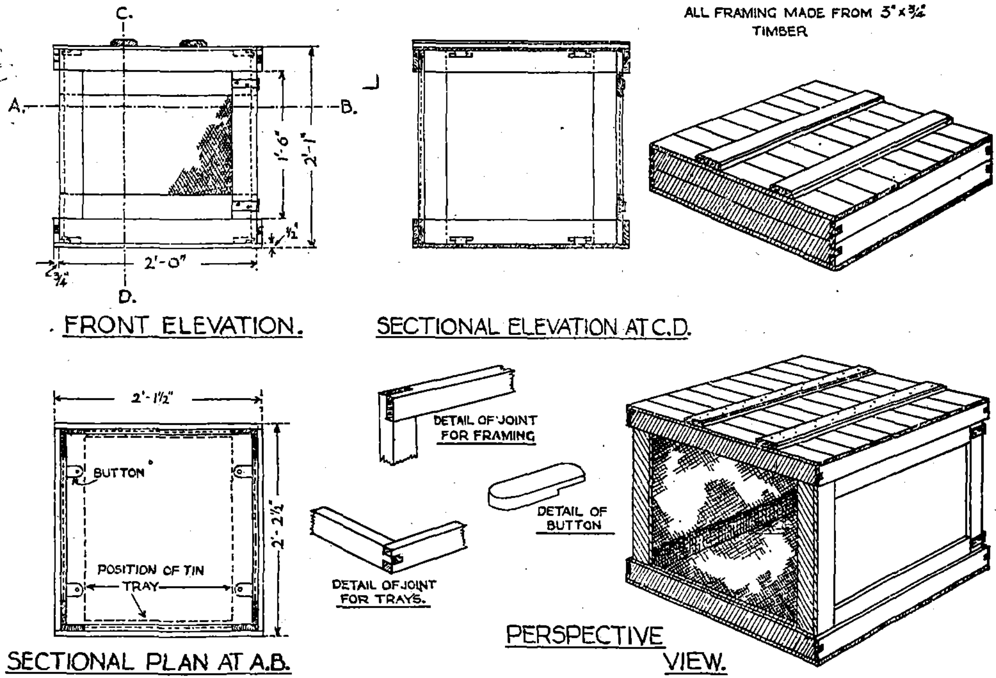


FIG. 14.—Portable fly-proof safe.

CHAPTER VI

SANITATION IN BARRACKS, HUTMENTS, BILLETS AND TRANSPORT SHIPS

Sanitation in barracks closely resembles that of the civilian community in that the necessary appliances are provided and maintained by the various responsible departments and only require the care of those living in barracks. There are, however, certain conditions which influence the health of the soldier in barracks as compared with the civilian.

The military community consists of a selected class of young men who have undergone a rigorous medical examination before enlistment and who are kept under close medical supervision during the whole of their service. The conditions under which they live are supervised and controlled by regulations, while practical measures for the prevention of disease can be put into force quickly and effectively. On the other hand, soldiers live a communal life and so are necessarily in closer contact with each other, with the result that there are greater opportunities for the spread of communicable diseases.

In modern barracks, the standard of health of the soldier is better than that of men of similar ages in civil life, but the incidence of diseases against which there are no special preventive measures is no lower than among civilians and may even be higher.

Many of the older barracks do not conform to modern hygienic standards, but for financial reasons they cannot all be replaced at once, so that it is necessary to adopt such sanitary measures as are possible to improve the conditions in such barracks ; this can only be done by the application of a knowledge of modern methods of sanitation under varying conditions, supported by good discipline.

There has been a gradual evolution in the type of barracks with improvements in design as shown below :—

1. Hollow square with barrack blocks built round a square—used before 1860.
2. Pavilion type with separate buildings spread out—as in use formerly at Chichester.
3. Half-battalion type with large connected buildings—built about 1900.
4. Unit type—as at Windsor and Redford.
5. Cubicle type—as at Windsor, designed to give each man a separate cubicle.
6. Modern 1933 type.

The modern 1933 type of barracks at home consists of single or double-storey blocks containing two barrack rooms on each floor, one room for thirteen men and the other for seventeen. Adjoining the smaller room is a non-commissioned officer's room, while leading from the space between each pair of barrack rooms is a sanitary annexe containing ablution basins, water closets and urinals for day and night use by the men occupying these barrack rooms.

Barrack room floors are of hard wood, polished and with rounded-off cove skirtings to prevent the accumulation of dust. Sash windows are placed between the beds on each side of the room, thus giving cross-ventilation without exposing men in bed to draughts. Each bed has six feet of wall space and a locker and towel rail above it. In the centre of the room are two slow-combustion open fireplaces, placed back-to-back, with one central chimney. Lighting at night is by electric light.

Barracks in foreign stations vary greatly in design according to the climate and special requirements of the local conditions. The chief factor affecting the design of barracks in foreign stations is the temperature. In hot climates, barracks have to be so constructed as to keep the inhabitants cool and to protect them from the glare of the sun and the downpour of rain during the monsoon; these results are achieved by providing double roofs, high ceilings, large windows and doors reaching to the top of the wall, raising the barracks on plinths well above ground level and providing good sub-floor ventilation and wide verandahs, while the onslaught of biting insects is prevented by screening with wire gauze.

Accommodation.—Communicable diseases are mostly spread by close personal contact, droplet infection or insects, and infection is, therefore, more likely to spread if men are crowded together.

Accommodation should be arranged so as to limit the numbers to small groups and to space beds far enough apart to prevent risk of infection by close contact or by droplets.

The amount of space to be provided depends on the range of droplet infection and the amount of air required by each man. The distance to which droplets may be sprayed out by a man is from 3 to 5 feet during quiet breathing, but during loud talking it may extend to 12 feet, while it may be as much as 24 feet during coughing, sneezing or shouting.

Beds should be arranged to provide a space of 6 feet between the men's heads when they are in bed, and with this in view each bed should have 6 feet of wall space. In old barracks where the shape of the rooms does not permit of each bed having the necessary wall space, the 6 feet may be obtained by

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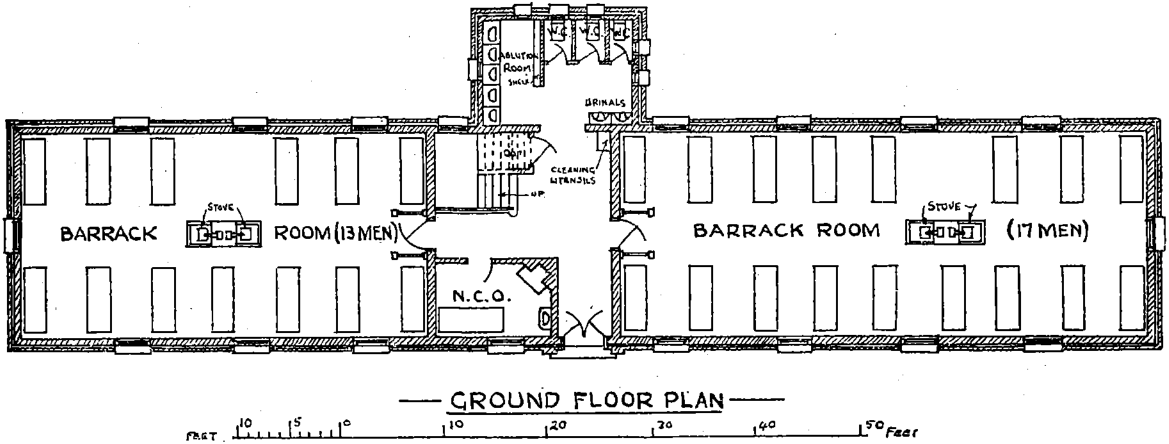


FIG. 15.—Plan of 1933 type barrack block.

reversing alternate beds so that men lie alternately head and feet to the wall; extra space can also be obtained by pulling some of the beds out into the middle of the room.

Droplet infection from men in bed may also be prevented by the provision of screens fixed to the wall between the heads of the beds; cheap and durable screens can be made of three-ply wood painted with a washable paint.

The approximate amount of fresh air required by a man is 1,000 cubic feet per hour and the air space to be aimed at is, therefore, 10 feet in length, breadth and height. The standard allowed in barrack rooms at home is 6 feet wall space, 60 feet floor space and a total of 600 cubic feet air space.

The accommodation provided in hospitals, guard rooms, schools and offices varies, as also does the accommodation in barrack rooms in foreign stations. (*See* Appendix 10.)

Quarters for married non-commissioned officers and soldiers are of three types, A, B and C, with one, two and three bedrooms respectively, and they are allotted according to the size of the family and not according to rank. A greater proportion of B-type quarters is provided, because more are required on account of the average size of families and also because two adjacent B-type quarters can be converted readily into one A-type and one C-type quarter.

Overcrowding.—This is one of the most usual faults in barracks and may be a general overcrowding or, more commonly, a local overcrowding of part of a barrack room.

General overcrowding is due to insufficient accommodation for the number of men occupying the barracks; it may only be temporary, as on the arrival of a new draft, or it may be due to the misappropriation of barrack rooms for other purposes, such as dining-rooms and stores.

Local overcrowding is to be found in many barrack rooms and is usually due to the placing of some beds close together while others are widely spaced out. This results from the square shape of the rooms or from the situation of the windows and doors in older barrack rooms necessitating the placing of beds away from draughts, or it is brought about by the fixing of shelves and lockers on the walls in pairs and the consequent "dressing" of beds in pairs under their respective shelves or lockers. Gross local overcrowding is frequently found in small rooms and married quarters, and particularly in guard rooms where tip-up beds are fixed close to each other on the walls.

Overcrowding can only be prevented by limiting the number of men in a room to the authorized quota, spacing out the beds irrespective of the position of shelves and lockers, and placing beds alternately head and foot to the wall when

the shape of the room and the position of doors and windows demand it. These measures necessitate good barrack room discipline and constant supervision on the part of officers and non-commissioned officers of the unit, who should ensure that such measures receive precedence over any desire to achieve smartness by regular dressing of beds under equipment shelves.

Ventilation.—Good ventilation means the provision of gently moving fresh air at a suitable temperature and humidity; it also implies the provision of a sufficient amount of cubic space and fresh air therein to ensure that the occupants of the room do not suffer from the effects of impurities in the air, such as gases and germs.

The composition of air and the effects of breathing into the air have been explained in Chapter II and it is therefore only necessary to repeat that the feeling of stuffiness and discomfort in a badly ventilated room is due to the stagnation of the air, together with a rise of temperature and humidity resulting from respiration.

A healthy comfortable atmosphere in a room depends on

(*a*) a temperature of about 60° F.
(*b*) a relative humidity not exceeding 75 per cent.
(*c*) a continuous gentle movement of the air at about three feet a second.

It is calculated that each person in a room requires 1,000 cubic feet of fresh air every hour, but, if the air is replaced oftener than three times an hour by incoming air more than 5° cooler than the air of the room, a feeling of draught results. A cubic capacity of 600 cubic feet for each person with the air changed twice an hour will give a little over the necessary 1,000 cubic feet of fresh air without a feeling of draught.

Ventilation may be either natural or artificial, but usually a combination of both is employed, especially for large rooms and theatres, and on board ship.

Natural ventilation is normally employed in barracks and is obtained by diffusion, wind movement and movement of the air by inequality of temperature, the air being replaced through doors, windows or specially made openings.

Diffusion takes place through bricks and other building materials, most of which are slightly porous, but it is too slow to be of practical importance.

Wind movement acts by perflation and aspiration. In perflation the wind blows into rooms through windows, or other openings, and to get the best effect rooms should be cross-ventilated, that is to say, there should be windows, or other openings, on opposite sides of the room so that the

wind can blow in at one and out at the other. Back-to-back houses are bad, because they do not allow of perflation.

Aspiration occurs when the wind blows across the mouths of chimneys and ventilating shafts and thus sucks up air through the chimney, or shaft, the air in the room being replaced by fresh air coming in through windows or other inlets.

Ventilation by wind movement is unreliable, as it cannot be controlled effectively; at times the wind is too strong while at other times, as on hot days when ventilation is needed most, there is little or no wind.

Inequality of temperature is the most effective means of natural ventilation. Its action depends on the fact that heated air expands and, as it expands, grows lighter and therefore tends to rise.

In a room where a fire is burning, there is in the chimney a column of heated air, which rises and in so doing sucks air out of the room. When a fire is burning in an open fireplace, an ordinary 9-inch chimney may draw up 20,000 cubic feet of air in an hour; after the fire dies out, the suction continues as long as the chimney is warm, and, when the chimney has cooled, the aspiration effect of wind still goes on. An open fireplace, therefore, if well situated, is a very important means of ventilating a room. The only drawback to fireplaces in barrack rooms is that on cold days men crowd round them to get warm and thereby increase the risk of droplet infection.

If cold fresh air is admitted at floor level, it will not mix well with the air in the room and it will also chill the feet and cause draughts along the floor. Inlets should be at a height of about 5 feet from the floor and so arranged that the incoming air is directed upwards towards the middle of the room, as in the Hinckes-Bird window, louvred panes, hopper windows, Tobin's tube and Sherringham's valve.

In addition to escaping by the chimney, the heated air in a room rises to the ceiling and outlets should, therefore, be made as high as possible; modern barracks have such outlets let into the ceiling. Outlet shafts should be vertical and as straight as possible.

Cowled ventilators on vehicles and ships may be made to act as inlets when turned to the wind or as exits through which foul air is aspirated by the wind when they are reversed.

Artificial ventilation

This occurs when the air is set in motion by mechanical means; it is chiefly employed in large halls, theatres, ships, mines and other places where natural ventilation is not sufficient and it may be done by extraction, propulsion or a combination of both.

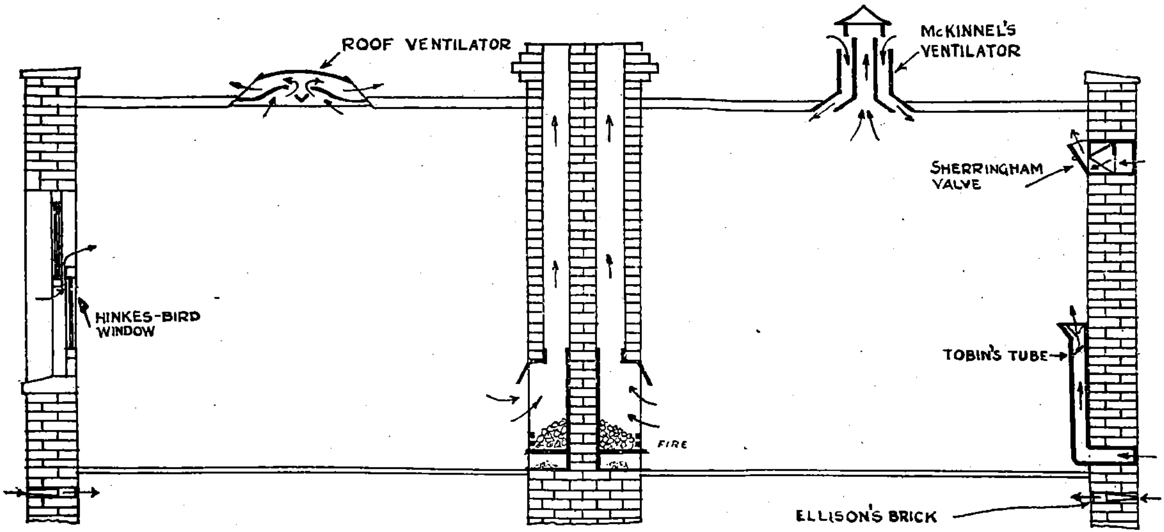


FIG. 16.—Modern ventilation.

Extraction.—The air is extracted by heat or by fans.

Extraction by heat is seen with the open fireplace, where the fire warms the chimney as explained above. Extraction shafts may also be heated by hot water or steam pipes or by gas jets. In McKinnell's ventilator, the foul air is removed in this way and the incoming air is warmed by contact with the outlet shaft.

Extraction by fans is the most common method and is used extensively in cinemas, theatres and factories.

The disadvantage of extraction methods of ventilation is that the incoming air is not easily controlled and may be drawn in from corridors, water closets or other undesirable places, even when special inlet openings are provided.

Propulsion or plenum system.—In this system fresh air is driven through ducts into rooms and definite outlets are arranged for the escape of foul air on the same side of the room but below the inlets. Its efficient working necessitates keeping windows and doors closed ; this is a disadvantage and for this reason it is not used in schools, where closed windows are a bad object lesson.

The advantages of the plenum system are that the source of the fresh air can be selected and the air conditioned ; consequently it is especially useful in hospitals, ships and places where large numbers of people collect for short periods, as in cinemas and theatres.

The combination of the extraction and plenum systems is known as the balance system. In working this, fresh air is usually forced by a fan into the building or space to be ventilated at suitable intervals and at a height of approximately 8 feet from the floor. Radiators or pipes heated by hot water at a moderate temperature are distributed along the walls at floor level. Foul air is drawn out by extraction fans placed in openings in the ceiling.

Air conditioning consists of treating the selected fresh air in such a way as to make it most beneficial to the community who are to breathe it. The air is cleaned and then dried, moistened, cooled or warmed according to requirements. This process is little used at present, but it is being developed ; it is especially useful in hot countries for cooling and ventilating hospitals and barrack rooms.

In hot stations abroad, natural ventilation of barracks is not sufficient and has to be assisted by artificial means. The most satisfactory method is by overhead electric fans placed along each side of the room between the beds, or by means of electrically propelled punkahs over each bed ; hand propelled punkahs depend for their efficiency upon human wakefulness and energy and are therefore unsatisfactory.

Control of ventilation in barracks

The best methods of ventilation will fail unless they are supervised, especially in cold weather when diseases caused by droplet infection are more prevalent and occupants of rooms shut the windows to increase the warmth.

"All barrack room windows should be opened wide, weather permitting, each morning when the troops vacate the rooms. The upper sashes should be kept open to the extent of at least one foot during the night." (King's Regulations, 1928, para. 1291.)

Regimental officers and also non-commissioned officers in charge of barrack rooms should make certain that this regulation is complied with; unexpected visits to barrack rooms at night or in the early morning will often reveal a complete lack of ventilation.

When the weather is cold men should be provided with extra blankets rather than that all windows should be shut at night. Particular attention should be paid to guard rooms, guard detention rooms and refreshment rooms.

Care should be taken that ventilators are working properly and have not been blocked up either accidentally or intentionally.

Workshops may require special arrangements for ventilation and removal of dust, while the danger of carbon monoxide poisoning necessitates the free ventilation of garages. Carbon monoxide is a deadly gas which results from the incomplete combustion of fuel such as petrol and coal gas and from the explosion of shells. The presence of a very small amount of this gas in the air is difficult to detect but may cause serious symptoms or death. Deaths from carbon monoxide gas poisoning occur in garages from the exhausts of motor engines, in trenches or dug-outs where braziers are alight, and in gun emplacements after prolonged firing. The domestic gas oven is a frequent cause of accidental or intentional death and gas cookers should, therefore, always be placed in well-ventilated sculleries and never in the living rooms of married quarters.

Heating

The warmth of barrack rooms is closely associated with ventilation. In the older types of barracks, heating is quite inadequate, especially where fireplaces are situated at the ends or on one side of the room, with the result that local overcrowding occurs from men congregating round the fireplaces and the risk of the spread of disease by droplet infection is increased.

Open fireplaces are the means of heating which will long

remain in use because of their popularity. They warm by radiation and convection and assist ventilation considerably, but their efficiency depends on an adequate supply of coal.

Stoves are used for warming huts, dining-rooms and bath houses. They are effective and economical, as rubbish can be burnt in them, but they are apt to become overheated and create a stuffy atmosphere from the charring of organic matter. When used in huts, they should be placed on concrete bases and precautions taken to prevent adjacent woodwork catching fire.

Radiators give more uniform heat, are cleaner and are under central control, but they tend to dry the air. They should be placed below fresh air inlets to warm the incoming air and to ensure gentle air movement for ventilation.

Central heating by the panel system, if properly installed during the construction of new buildings, gives the best results. An even temperature is maintained throughout the whole room and this obviates local overcrowding round fireplaces and therefore lessens the risk of droplet infections; moreover, there are no radiators or hot pipes on which wet clothing can be dried and behind which dust and rubbish can accumulate. The system is economical in fuel in single buildings as hot water and steam for cooking, baths and heating are all available from a central supply; it is unfortunately an expensive method of heating disconnected barrack blocks. Owing to the absence of extraction of air by open fireplaces, special arrangements must be made for ventilation when there is a central heating system.

The warming of dining-rooms in modern barracks is carried out by means of special appliances such as blowers (Carrier-Yorke), or thermostatic control systems.

Lighting

Lighting must be sufficient by day and until "lights out" at night. Rooms that are badly lit by day are unhealthy and are not likely to be kept clean, while, if artificial lighting is inadequate in the evening, men will leave barracks for better lit but perhaps less desirable places. Scales of artificial lighting are given in Regulations for Supply, Transport and Barrack Services, 1930, Appendix 25.

Natural daylight should be provided by glazed windows equal in size to one-tenth of the floor area in barracks and one-fifth in schoolrooms. Artificial lighting should be by electricity. Existing sources of lighting should not be reduced unduly by accumulations of dust, paint, curtains or unauthorised screening.

In foreign stations, special arrangements are necessary to admit sufficient daylight but at the same time to exclude glare and dust.

Lighting in schoolrooms requires special consideration as regards the seating of the scholars and the placing of blackboards in the best positions. The scholars should be seated so that the light is behind them and to their left, *i.e.* comes over their left shoulders. The blackboards should have a dull matt surface, they should be in a central position and not raised unduly above the level of the eyes, while at night they should be flood-lit.

Cleaning

Modern barracks are provided with polished floors and the skirtings between walls and floors are rounded off to make easy cleaning possible. In many barracks the floors are made of soft wood and are uneven. Such floors are therefore difficult to polish and, to avoid raising dust, should be cleaned by damp brushing or by the use of dust preventers.

Wet scrubbing should only be carried out when absolutely necessary and then the room should be vacated until dry; on no account should blankets be placed on the floor while it is drying.

Vacuum cleaning with electric power is the most hygienic method of cleaning rooms, especially offices and similar rooms where there is an increased risk of tuberculosis, but it cannot be adopted in barracks until the necessary appliances are provided and the use of electric power for this purpose is sanctioned.

All passages and annexes, such as lavatories, urinals and latrines, should be scrubbed out regularly, but the practice of leaving quantities of strong cresol solution lying on the floor fulfils no useful purpose and is wasteful.

The cleaning of the outside of barracks and their surroundings is the responsibility of the unit in occupation.

Ablution arrangements

Wash basins on a scale of 14 per cent. should be provided in ablution rooms. The basins should be of glazed earthenware fixed in a slate bench, which should be flush with the edge of the basin to prevent the accumulation of dirt between basin and bench.

The basins should be fitted with taps and the waste water discharged through a water-sealed trap and thence through a gully trap into the drainage system. The traps under the basins and the gully traps require to be cleaned regularly.

Baths

Slipper baths and those of the combined shower and foot-bath type are provided on the scale of 1 per cent. slipper baths and 4 per cent. combined shower and foot baths for rank and file, with one extra of each type in each bath house for single serjeants.

Baths are usually provided in a separate bath house block, but where not so provided they may be included in the sanitary annexe of barrack blocks.

Slipper baths require about 15 gallons of hot water for each bather, and more than this amount should not be provided or the bather will not be able to soap himself thoroughly while sitting; the provision of so much hot water frequently for all men in barracks is difficult and cannot be done on the authorized scales of fuel. The slipper bath has also the disadvantage that the dirt from the body remains suspended in or floats on the water in which the bather lies and, when he rises from the bath, most of the dirt adheres to his body; it is then partly rubbed into his skin again in the process of drying and partly removed on the towel. Furthermore, when the dirty water is being run out, a great deal of dirt sticks to the sides of the bath and, unless it is cleaned off at once, which is rarely done during bathing parades, it will dry and become difficult to remove, with the result that the dirty bath may convey infection to succeeding bathers and give rise to skin diseases.

Combined shower and foot baths only require about 4 gallons of water for each bather, soaping of the skin is not interfered with and the dirt is flushed off the body by the shower, which also has a stimulating effect on the skin; moreover, a bath under a shower takes less time than one in a slipper bath, and this is an important factor when large numbers of men are to be bathed. The combined shower and foot bath is, therefore, much to be preferred, both for hygienic reasons and on the grounds of economy of money and labour.

Every man living in barracks should be made to bathe at least once a week and his attendance should be checked by the use of a bath register or bath ticket; while this check is necessary in order to protect men of clean habits from the few who neglect their personal hygiene, the chief difficulty at the present day is not to ensure weekly attendance, but to provide enough hot water during the hours when men are free to bathe. Where slow combustion boilers are the source of heat for the bath water, inadequacy of the fuel supply may be made up partly by the use of dry refuse as fuel.

Regular bathing leads to a very definite reduction in the numbers of men reporting sick with skin diseases, and, in

addition, the free use of shower baths after games and physical training adds considerably to the healthful effect of such exercise.

Swimming baths

These are not provided universally in barracks, but they exist in certain garrisons and their benefit to troops in hot weather cannot be overestimated. They must, however, be very carefully supervised or they become a route for the spread of diseases ; many cases of middle ear disease have been attributed to the use of swimming baths.

The best type of swimming bath has a system whereby the water is kept circulating and undergoes continuous purification ; these, unfortunately, are rarely found in barracks, where the usual procedure is for the water in the bath to be changed fortnightly or even monthly with the result that the water becomes very foul, unless some system of purification is adopted.

The chief sources of pollution of swimming baths are the bathers themselves and the following sanitary measures should, therefore, be adopted :—

1. Inspection of bathers, to ensure that no one uses the bath who is suffering from diseases of the skin, ears, nose or throat or who has been under treatment recently for any such diseases.
2. Provision of urinals and latrines near the bath, particularly for the use of men before entering the water.
3. Provision of showers and footbaths in such positions that men can use them immediately before entering the swimming bath.
4. Provision of spittoons round the edges of the bath in such positions that the bathers can use them without leaving the water.

Swimming baths should be emptied periodically and the sides and bottom scrubbed to get rid of the slime which collects. They should then be dried and whitewashed (if the bath is not tiled) before refilling.

Drying rooms

The drying of clothes in barrack rooms is most undesirable, as it leads to greatly increased humidity of air and creates a very unpleasant stuffy atmosphere.

Drying rooms are authorized in special cases with War Office authority.

Messing

Before the Great War of 1914–18, special dining halls were not provided and men not only had their meals in their barrack rooms, but also kept their food and mess utensils in cupboards in these rooms. When the hygienic objections to this practice were understood, certain barrack rooms were misappropriated as dining halls, but this innovation was objectionable because it lessened the available accommodation in barrack rooms and so led to overcrowding; in many cases the misappropriated rooms were at a distance from the kitchen and consequently meals were cold before they reached the men and there were no adequate means for washing-up.

In all new barracks a special building is now provided and includes all the requirements for cooking, messing and washing up. In the kitchen block there is a cook's lobby with cupboards for clothing; a food-preparation room provided with hard wood-topped benches, a slate-topped bench, a cupboard for cleaning materials, two deep fireclay sinks supplied with hot and cold water taps and fitted with a draining board, and a mechanical vegetable paring machine; a cookhouse, fitted with suitable cooking apparatus, which is heated by fires stoked from outside so as to prevent smoke, dust and undue heat in the cookhouse, a washing trough and rack for pots and pans and a fireclay sink; a servery, with two combined hot closets and serving counters, and opening off it a bread store with batten shelving; a meat larder with slate shelves and meat hooks on rails and also a general larder.

The dining-room accommodates 85 per cent. of the rank and file, including married men, with 9 square feet of floor space and 20 inches run of table for each man in home stations; a cupboard is provided for table requisites and the room is heated by radiators, Carrier-Yorke blowers or some other central heating system.

There are two washing-up rooms, one large one fitted with a mechanical washer, sinks for washing plates, mugs and glasses, plate racks and cupboards, and the other situated off the entrance lobby of the dining-room for men to wash their knives, forks and spoons. The practice, still in vogue in some units, of each man washing his own mess utensils, drying them with his body towel and storing them with his clothing in the barrack room is most unhygienic and should be forbidden; all mess utensils and cutlery should be kept in the dining halls or washing-up rooms between meals.

Outside the kitchen block is a boiler room with coal and coke stores opening off it.

The sanitation of kitchens and dining halls has been dealt with already in Chapter V, and it is only necessary to repeat

here that special attention must be paid to the cleanliness and freedom from disease of all persons engaged in the preparation, cooking or handling of food, the protection of food from contamination, the provision of a well-balanced and well-cooked varied diet in an appetising form and in pleasant surroundings, and lastly the disposal of refuse and the cleaning of cooking and messing utensils. (*See also* Appendix 8.)

Cookhouses and dining-rooms in many of the older barracks are much inferior to those in the modern barracks described above, but, until they are replaced, such methods must be adopted as will make them as good as possible.

Washing-up arrangements fall short of requirements in most barracks, and the usual practice of washing large quantities of utensils in a small quantity of lukewarm water results in inadequate cleaning of the utensils and considerable danger of the spread of disease. Every effort should be made to supply a sufficient quantity of water, kept almost boiling, and an ample supply of soap, soda and clean dish towels for drying utensils.

The exterior of cookhouses should be kept clean; grease traps (when used) should be kept in good working order and all drains in good repair.

Refuse bins should be made of metal and have handles and loose-fitting lids with flanges coming down over the sides of the bin. Wooden receptacles are not suitable for refuse, although barrels may be used for wet refuse, such as swill, provided they are watertight and have good lids. Bins should stand on a hard, smooth, impervious plinth to prevent the fouling of the surrounding ground.

Institutes

The provision of institutes in barracks is recognized as an important factor in the preservation and promotion of the health of the soldier. They provide refreshments which are prepared under hygienic conditions and are under the supervision of the medical authorities; in addition, by their general standard of comfort and the facilities which they provide for reading, writing and recreation, men are induced to remain in barracks and thereby avoid the risks attendant on visits to less desirable places. On the other hand, institutes may become a means of spreading communicable diseases to the troops for the following reasons:—

1. They are meeting-places where men come in close contact with one another and consequently disease can easily be spread, especially if there is any overcrowding, as occurs in rush hours, when men queue up at counters to obtain their requirements.

2. Cups, glasses, forks and spoons may become routes of infection unless they are sterilized after use; during busy periods such sterilization is often not carried out or is done imperfectly.
3. Communicable diseases may be introduced from outside by civilian attendants.

In addition, therefore, to the ordinary sanitary supervision, special attention must be paid to ventilation, the prevention of overcrowding, washing-up arrangements and the health of civilian attendants.

Ration stores

These should be well ventilated, dry and well lit, while bread and meat stores should be flyproof and ratproof, especially in hot climates. Chopping blocks, butchers' knives and other appliances should of course be kept clean.

Conservancy

Conservancy in barracks is more simple than in the field because the necessary appliances are provided by the authorities. There is a water-carriage system of drainage and refuse is removed by contractors.

The waste products to be dealt with consist of fæces, urine, sullage water, kitchen refuse, dry refuse and manure, and the sanitary appliances required for the collection and removal of these are latrines, urinals, sinks, drains, refuse receptacles, rubbish carts and manure platforms.

Latrines

In most barracks pedestal wash-down water closets, connected to a water-carriage drainage system, are provided on a scale of 6 seats for every 100 men with one additional seat in each block of latrines for serjeants. In some stations, where the introduction of a water-carriage system would be difficult or too expensive, the bucket removal system is still in use.

The essential part of the pedestal water closet is the water trap, as this forms the only means by which the closet is disconnected from the drain. Care must be taken that a good water seal is maintained in the trap, that the pan is not cracked and that the joint with the soil pipe is watertight.

The closet is flushed with water from a flushing cistern which must be kept in good order; the pan should be flushed out every time after use and nothing likely to block the drains must be thrown into the closet.

The best type of latrine seat is one which permits of the

feet of the occupant resting comfortably on the ground and in which the seat slopes downwards from the front to the back. With this pattern the user is as nearly as possible in the natural squatting position, and straining at stool, which is conducive to the production of rupture and piles, is avoided. Latrine seats of this pattern are now being given a trial in the Army.

Latrine seats should be scrubbed daily with soap and water, and weekly, or oftener if soiled, with 1 per cent. cresol solution.

Closet pans, when they become stained, should be cleaned with a brush and occasionally with spirits of salts, " Harpic,"

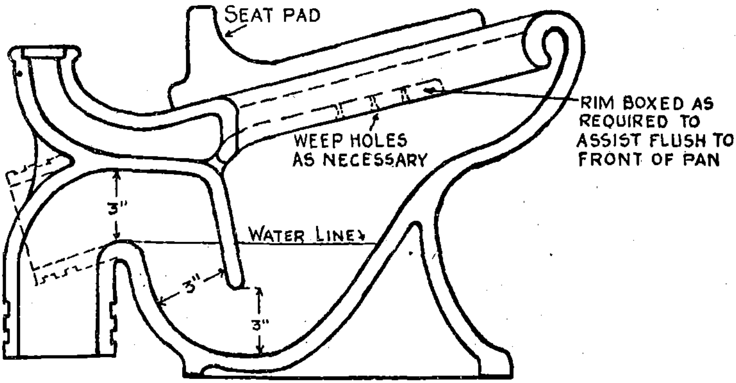


FIG. 17.—Squatting pattern wash-down water closet.

or other similar preparation. Latrine floors should be kept clean and latrine paper provided in each compartment.

Urinals

The modern pattern of urinal consists of separate curved stalls made of glazed stoneware and flushed by automatic flushing cisterns. In some barracks and for outdoor use, slate urinals are still in use ; these should be treated every two or three days by applying mineral oil to all surfaces likely to be wetted by urine.

The urine channels should be well flushed out and cleaned daily, as insufficient cleaning of these channels is usually the cause of the unpleasant smell from some urinals.

Floors for a distance of a foot from the urinal are particularly liable to fouling and should be cleaned daily.

Urine buckets should be placed near barrack rooms for use at night when no proper urinals are available, but they are

insanitary and should be abolished as soon as proper flush-down urinals can be provided; when night urine buckets are used, they should be removed every morning, emptied, cleaned and have a little cresol solution put in them. They should be kept outside barracks during the day.

Sinks

These should be deep and made of non-absorbent material and should have no sharp corners in which grease can collect; some barracks have teakwood sinks, but those made of glazed fireclay are preferable.

The draining board should be flush with the inside edge of the sink and not overlap it, or grease will collect below the edge of the board.

Sinks are provided with a trap which has a screw plug below to allow of cleaning, and they discharge either into a gully trap leading into the drains or into a grease trap and thence into a soakage pit.

Sinks should be scrubbed out daily with hot water, soap and soda, and the waste pipe flushed with boiling water; otherwise the sink becomes coated with grease and the waste pipe blocked.

Drains

Surface drains carry off rain water and run into gully traps covered with gratings; they are under the care of the troops and must be cleaned monthly.

Other drains receive the contents of latrines and urinals and sullage water from sinks, baths and wash basins. These foul drains are provided with traps and ventilation shafts to prevent foul air entering buildings; also, at certain points along the drains, manholes are provided for inspection and cleaning. These drains are under the charge of the Engineer Services, but the manholes are opened and the drains cleaned and flushed by the troops, under Engineer supervision.

Refuse

Wet refuse from kitchens is usually removed by contractors and the sale of swill is a useful addition to unit funds.

Dry refuse may be collected and removed by municipal authorities or contractors, but it is preferable to burn it in incinerators; part of it may be used as an addition to the fuel supply for heating water. When incineration is the method of disposal, a well-built, closed incinerator is necessary and extra fuel may be required. When disposal is by removal, the vehicles used should be of a type specially constructed for the purpose or at any rate they should be of sound construction

and provided with good covers; the use of ordinary carts covered with sacking should not be allowed.

Manure

In this mechanical age the disposal of manure and stable litter is usually not difficult, as it is sought after by farmers and gardeners. While awaiting removal, manure should be placed in properly constructed manure pits consisting of a cement platform surrounded on three sides by a smooth impervious wall; the floor should slope slightly to the open side, where a drain, emptying into a sump pit, should be provided to catch liquids draining from the manure. The sides of the pit and of the drain should be provided with baffles to prevent the escape of fly maggots. To prevent fly-breeding, the pits should be

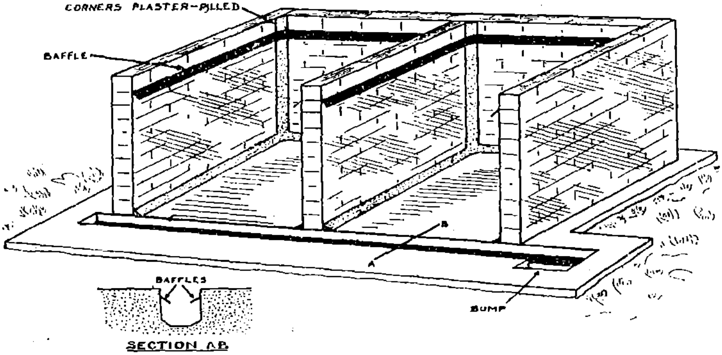


FIG. 18.—Double Collecting Manure Pit.

built in duplicate and each should be capable of holding one day's accumulation of manure, to ensure that one is emptied and cleaned each day.

All units with animal transport should have at least one pair of these pits and the collection and removal of manure should be supervised carefully, especially when a contractor is employed, to prevent excessive accumulation in the pits.

Hutments

Hutments are usually provided for standing camps, but may be erected to cope with a temporary increase in the strength of a garrison or to overcome a temporary overcrowding in barracks.

The standard of comfort is not so high as in barracks, but the standard of sanitation snould not be lower as the same sanitary appliances are usually provided.

It may be said, therefore, that sanitation in hutments closely resembles sanitation in barracks.

Billets

Billets are made use of in peace time when parties of more than ten soldiers proceed on temporary duty to places at which troops are not quartered, where there is no barrack accommodation, or when they are not encamped. (King's Regulations, 1928, para. 1052.)

On active service, billets are the usual form of quarters in civilized countries when the troops are not in close proximity to the enemy; they allow of proper rest and give shelter from the weather and from observation from the air, while the cellars of houses afford cover from bombardments or aerial attack. (Field Service Regulations, 1930, Vol. I, Sec. 141.)

When troops have to be concentrated in an area, they may be put into close billets, when as many men as possible are accommodated in buildings and the remainder are bivouacked.

Billeting parties should ascertain from the mayor, civil authorities, medical officer of health, local doctors or police, details of the local water supply, the conservancy system, the health of the local population and the existence of communicable diseases.

The local authorities are required to take such sanitary measures as may be needed to render the selected premises suitable, but the assistance of the troops is usually necessary, and advisable, for the construction of additional cookhouses, latrines and washing places. Notices should be posted on the doors of houses where there are infectious diseases and any other houses where it is undesirable to quarter men.

Cover is all that can be expected in billets on active service and any premises which are, or can be made suitable for human occupation may have to be used; when it is not possible to put premises into a satisfactory sanitary condition, and no others are available, it is better that the troops should bivouac.

Accommodation in billets can seldom be provided on the same scale as in barracks, and overcrowding, particularly in close billets, is unavoidable; special attention must therefore be paid to ventilation, cleanliness of premises and conservancy. Satisfactory ventilation is difficult to maintain, unless officers and N.C.Os. ensure that air inlets are kept open. Extra latrine, urinal and washing accommodation should be provided as soon as possible, as such civilian conveniences are frequently inadequate and unsuitable; for this purpose it may be necessary to employ civilian labour, but their work should be supervised by military sanitary personnel.

Water supplies must be supervised and purification should be carried out by the military authorities where existing methods are inadequate.

The units in occupation are responsible for the sanitation of billets and for leaving them in good sanitary condition. When the same billets are to be occupied by successive bodies of troops, it is of the utmost importance that they be left scrupulously clean, and, in order that this may be done, it is necessary to have a system of reliefs and a final inspection to prevent the common complaint that billets have been left dirty by the previous occupants. Improvised sanitary appliances should be left in a clean condition, or, if no longer required, they should be dismantled, the pits filled in and the sites marked and pointed out to the local authorities.

The scattered nature of many billets makes their sanitary supervision difficult, especially when being vacated, and only good discipline and close supervision will give satisfactory results.

Transport ships

There are very few officers or other ranks in the Army who do not experience life in a transport ship at some time or other. The special conditions of crowding, lack of exercise, excessive heat and lack of ventilation make the sanitation of transport ships more difficult and the risk of spread of disease greater than on land ; moreover, troops landing from transports after long, hot journeys are often in poor physical condition and liable to break down if exposed to hardships.

Inspection of transports

Before being fitted out, ships to be employed for the transport of troops are inspected to determine the best use of the space available and the approximate numbers of the various classes which a ship can accommodate.

They are inspected again before embarkation, immediately before sailing and again after disembarkation ; a daily inspection is also carried out during the voyage by the ship's captain, O.C. troops and senior medical officer with a view to discovering and rectifying any conditions adversely affecting the health of the troops on board. More detailed daily sanitary inspections are carried out by the orderly medical officer and the N.C.O. i/c sanitation appointed for the voyage.

Medical inspection of personnel

This is carried out as follows :—

1. Troops.—One month before embarkation, the day of or before departure from their stations, the day after embarkation and the day before disembarka-

tion. (King's Regulations, 1928, paras. 1104 and 1105, and Voyage Regulations, 1928, para. 196.)

2. Families.—Within 3 days of embarkation. A certificate of health and details of vaccination and inoculation, on A.F. B 155, signed by a medical officer, must be handed to the embarkation medical officer. (King's Regulations, 1928, paras. 1106 and 1107.)
3. Ship's Crew.—Before sailing by the embarkation medical officer in conjunction with the ship's surgeon, where there is one. (King's Regulations, 1928, para. 1089.)

Berthing

Hammocks are provided for the total number on board less 25 per cent. representing those on night duties. They are 9 feet

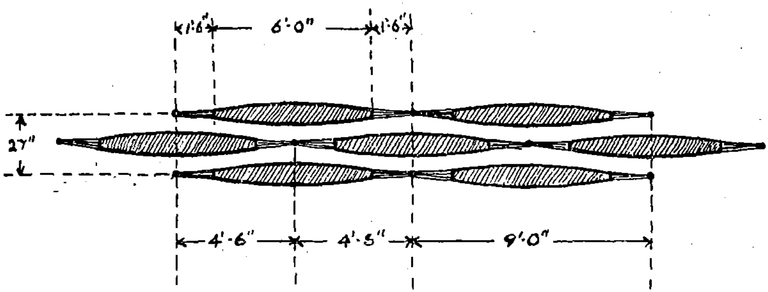


FIG. 19.—Plan for berthing hammocks in transports for troops.

in length and are slung from hooks spaced 27 inches apart on an interlocking system in such a way that there is always the middle of one hammock between two men's heads; the head hooks are painted white and the foot hooks black while those for serjeants are painted red.

This method of berthing has led to a marked decrease in diseases due to droplet infection.

Messing

Sufficient table accommodation is provided for the full number on board, allowing a minimum of 20 inches for each man; tables are usually 15 feet long and accommodate 18 men each.

Ablution.—Wash basins are provided on a scale of four per cent., with an additional three basins for serjeants.

Shower baths are provided on a scale of two per cent., with an additional two for serjeants; one-half of the former and the two for the serjeants are fitted with a hot and cold salt water supply and the remainder with a cold salt water supply only.

Latrines and urinals.—Four latrine seats are provided for every 100 men up to 300 and two for every additional 100, with an additional two for serjeants. Urinals are fitted along the whole length of the inside wall of the latrine.

Ventilation.—This is always difficult on board ship, especially in the tropics. The supply of fresh air must be direct and should enter through scuttles, companion ways, cowl air shafts, hatches provided with wind sails or other such entrances. It is usually necessary to supplement this system of ventilation with a system of propulsion consisting of an air shaft from the upper deck supplying fresh air at the rate of at least 2,000 cubic feet a minute by means of a blower fan; in order to diffuse the fresh air and to prevent draughts, the delivery should be directed towards a bulkhead.

The ventilation of latrines, ablution compartments and places where food is stored or prepared is by extraction.

Cleaning.—The troops clean their own and the families' quarters, but cleaning materials are supplied by the ship's owners.

The mess decks must be swept, scrubbed and dried with flannels, but salt water must not be thrown on them.

Special precautions for troops going east of Suez

1. Electric fans must be provided on all troop and mess decks and in all cabins and hospitals.

2. Double awnings must be placed over all deck spaces.

3. Ice should be provided on a scale of two pounds each person per diem, but this may be increased on the recommendation of the senior medical officer. Ice must also be available for the treatment of heat-stroke cases.

4. Mineral waters should be provided on a scale of two bottles for each person daily, but may be increased.

5. Ample washing and bathing accommodation must be available day and night and canvas swimming baths should be provided on the scale of one for up to 500 men and two for 500 to 1,000.

6. Sleeping accommodation on deck should be made available for as many as possible east of Suez, especially in the Red Sea.

7. A heat-stroke station should be arranged in accordance with the suggestions contained in Memoranda on Medical Diseases in Tropical and Sub-Tropical Areas, 1930, pages 134 and 135.

8. Sun helmets should be in good order and worn by every one after passing Port Said.

The Crowden pattern helmet with a dropped lining of aluminium foil and the Vero headband to ensure ventilation reduces the temperature of the head by 6° to 10°.

CHAPTER VII

SANITATION IN THE FIELD

"The Commander of every formation and unit in the field is responsible for the sanitary condition of the area occupied by his command, irrespective of the period for which it may be occupied, and for the enforcement of all orders regarding health and sanitation." (Field Service Regulations, Vol. I, 1930, Sec. 145.) Sanitation in the field differs from that in barracks to a great extent, because troops are living under more adverse conditions ; the hygienic principles are the same, however, although their practical application may have to be varied and very often improvised.

Adverse conditions in the field.

1. The men are necessarily crowded together much more than in barracks and there are, therefore, greater opportunities for the spread of communicable diseases.

2. The occupation of camps, billets or other quarters is for comparatively short periods and sanitary methods and appliances have usually to be improvised ; repeated moves make the men careless of sanitary rules, and the destruction of sanitary appliances by enemy action may cause a certain amount of disorganisation.

3. The necessities of sanitation are no longer carried on by special departments as in barracks, and the men, accustomed to civilian or barrack life, fail to realize that it is necessary for them to carry out their own sanitary measures. When units first take the field, a marked lack of adaptability to field sanitary methods is always to be found and is manifested by an outbreak of preventable disease ; this proneness to early outbreaks of disease can only be prevented by education in field sanitation in peace and the inclusion in units of men trained in sanitation.

4. Water supplies must always be considered as liable to pollution, and therefore dangerous, while methods of purification must often be rapid and therefore imperfect.

5. Insect carriers of disease become more prevalent when there is any relaxation of sanitary precautions.

6. Fatigue, exposure, scanty or imperfectly cooked food and unaccustomed climates lower the soldier's vitality, and consequently his resistance to disease.

Education in peace time, by attendance at classes and courses of instruction, is the only way in which officers and other ranks can learn the principles and methods of sanitation, and the knowledge so gained should be put into practice during training periods in camp. Practical sanitation cannot normally be learnt in barracks or annual training camps, as most of the necessary work is carried out by contractors.

Anything, however small, which affects, or may affect, the health of the troops must receive attention. Whenever possible, a preliminary sanitary reconnaissance should be made of any area to be occupied by troops and all available information obtained regarding it; lack of previous military medical intelligence reports has frequently led to severe outbreaks of preventable disease, as for example in the case of troops occupying areas which are afterwards found to be intensely malarious.

Orders dealing with sanitation should be published in the form of routine standing orders and special local orders, which should be brought to the notice of all concerned. Once published, such orders must be enforced strictly, although the willing co-operation of all ranks, based on knowledge gained from education in sanitary principles, is much more effective than action enforced by orders.

The following points require special consideration for the preservation of the health of troops in the field :—

1. The provision of an adequate supply of safe drinking water and its protection from contamination, together with good water discipline of the troops.
2. The protection of all food supplies from contamination, maintenance of the highest possible standard of cooking and messing, and the control of the sale of perishable goods to the troops by hawkers and camp followers.
3. Ventilation of tents or other quarters.
4. Adequate arrangements for washing and disinfestation of the men and their clothing.
5. The disposal of excreta, refuse, manure and other waste products, also dead animals, in such a manner as to prevent the introduction or spread of disease, the breeding of insects and the pollution of water supplies.

Camps

Camps are used for the concentration of troops and for field training; they are usually healthy, provided due regard is

paid to the selection of sites and to their sanitation, for it must be remembered that diseases such as typhoid and dysentery are brought by the troops themselves and the extent to which they spread depends more on the sanitation of the camp than on the ground on which it is situated.

Selection of camp sites.—Military necessity must take precedence over everything else in the selection of a camp site, although the proximity of water and the facilities for obtaining fuel and supplies must be considered ; whenever possible, the following points should be taken into account :—

1. Nature of surroundings.—Neighbouring towns and villages may be sources of infection. Broken ground is frequently an encouragement to bad sanitation and may harbour sandflies, snakes or vermin. Swamps and the banks of streams may provide breeding grounds for malaria-carrying mosquitoes.
2. Water supply.—A good water supply near at hand is desirable, but military considerations of safety may necessitate the camp being placed at some distance from it.
3. Nature of ground.—High ground with good drainage and covered with grass is to be preferred. Steep slopes should be avoided, but gentle slopes facilitate drainage. Large woods with undergrowth and low meadows with thick grass are unhealthy. The bottoms of narrow valleys, ravines and watercourses are liable to flooding and are therefore dangerous. Newly turned soil is apt to become a quagmire in wet weather or very dusty in dry weather. Camp sites which have been occupied by other troops within the previous two months should be avoided, if possible.
4. Approaches.—The site should have easy approaches, preferably off the main line of traffic, and be one that is not likely to become boggy in wet weather or dust tracks in dry.
5. Space.—Sites should be selected as if for continued occupation, for a bivouac or temporary camp may develop later into a permanent camp ; they should be large enough to permit of ample spacing yet not too large, as the difficulties in the sanitation of a straggling camp are thereby increased.

The best sites for camps, therefore, are to be found on gentle grassy slopes on fairly high ground with gravel soil, open to the wind but not too exposed, with good approaches, ample space and a convenient water supply. Camp sites are selected

by a staff officer in conjunction with an engineer and a medical officer.

Lay-out of camps

The following points should be borne in mind in laying out a camp, although modifications may have to be made on account of the physical configuration of the ground or other considerations, such as the necessity for concealment from the air :—

1. The front of the camp should face the prevailing wind.
2. The sleeping accommodation should be in front, with kitchens and messing accommodation nearby at one side.
3. The transport lines for animals and vehicles should be concentrated in special areas in the rear. This applies particularly to composite camps for several units, where the establishment of one animal picketing ground for all units has a marked effect in reducing fly breeding.
4. The conservancy area should be concentrated to leeward but not too far away and not in a situation likely to pollute the water supply.
5. The ablution area and water point should be at one side, away from the conservancy area, and with drainage so arranged as to prevent the waterlogging of the camp.
6. The camp roads, allowing easy transit, should be so arranged that traffic through the camp for watering horses and the delivery of supplies does not cover the cooking and messing areas with manure-filled dust.
7. Surface drainage through the camp should be provided.

The following plan is intended only as a guide on which to base the lay-out of a camp ; tentage would vary according to the strength of the unit and, where several units are encamped together, modifications will have to be made to prevent the conservancy area of one unit being near the cooking and messing area of another. The lay-out of a multiple camp should be planned by a staff officer, or the senior officer present, in conjunction with a medical officer, with a view to the grouping and combination of conservancy and transport areas.

Camping arrangements for a force on the line of march

A staff officer, accompanied by an engineer officer, a medical officer and mounted police, goes forward to select the ground

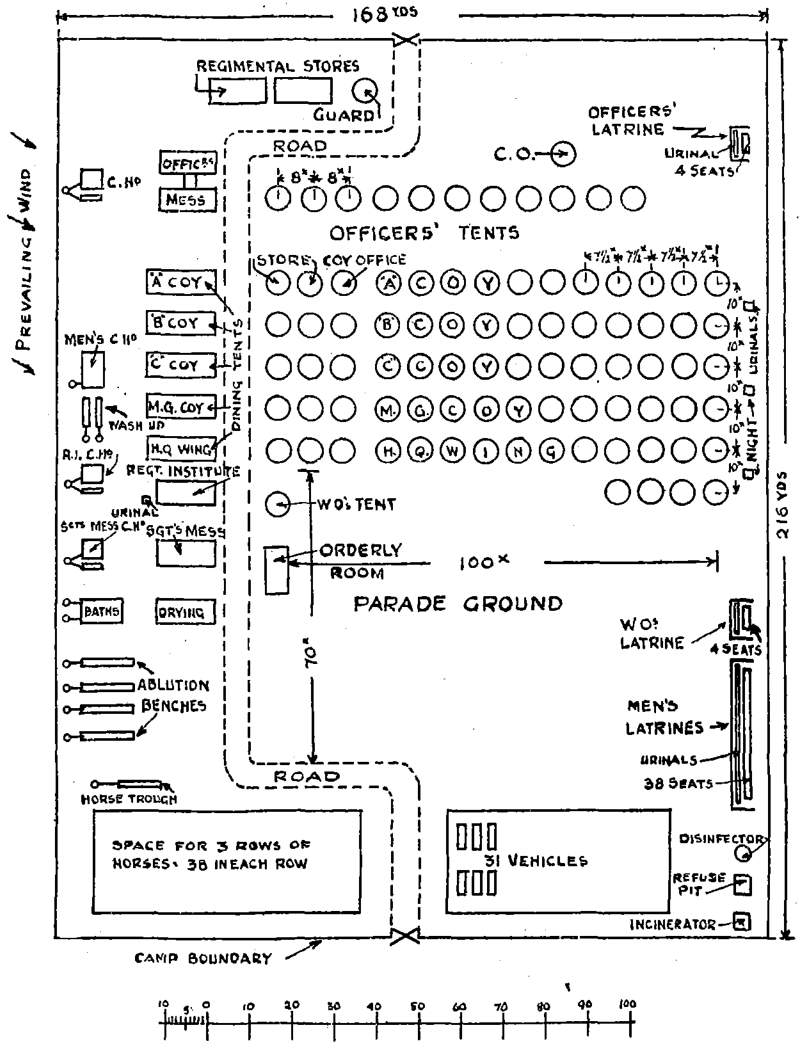


FIG. 20.—General Sanitary Principles of Lay-out of a Camp Site for a Battalion.

where the force is to camp. When the column approaches within 2 or 3 miles of its destination, staff officers of brigades, etc., accompanied by unit representatives, go forward, receive instructions concerning the arrangements for the camps and lead in the units on arrival to the ground allotted to them. The engineer officer and the medical officer examine the water supply and make any necessary arrangements for purification and distribution. The medical officer gives advice regarding the siting of latrines, conservancy and other areas; he also makes a general survey of the area and obtains information concerning any sickness among local inhabitants, or other conditions which may affect the health of the troops. Sanitary arrangements must be made as soon as possible and some latrine and urinal accommodation must be prepared for the troops, camp followers and labour gangs, before their arrival in camp, otherwise fouling of the ground is sure to occur.

On the arrival of a unit at a new camp, the lay-out of the camp should be explained to all ranks before they fall out. This procedure prevents the fouling of the camp site, which is very liable to occur when the location of latrines, urinals and other camp sanitary arrangements are unknown to the troops.

On striking camp, the whole area must be left clean, and for this purpose it is essential that a staff officer and a medical officer should remain with the rear parties to ensure that they do not leave until they have completed their work of cleaning up. The final disposal of all refuse and animal litter should be by burning or burying and no dumps must be left uncovered. All latrines and pits must be filled in and their sites marked clearly for newcomers to see. Areas occupied by contractors, camp followers and labour gangs require special attention.

Temporary camps and bivouacs

Temporary camps and bivouacs are intended for occupation for a maximum of three nights but their sites should be selected as if for continued occupation; accommodation is usually restricted, but the spacing should be as much as the military situation permits, so that there will be no overcrowding or undue straggling.

Sanitary appliances are usually of the simplest type and have to be improvised, but, if the occupation of the site is prolonged, they must be replaced by more permanent structures as soon as possible; for example, shallow trench latrines should be replaced by deep trench or bucket latrines, temporary incinerators by others of a more permanent type, and pit or tin grease traps by those of the baffle plate type.

Camp sanitary appliances are described in Chapter VIII.

Semi-permanent camps

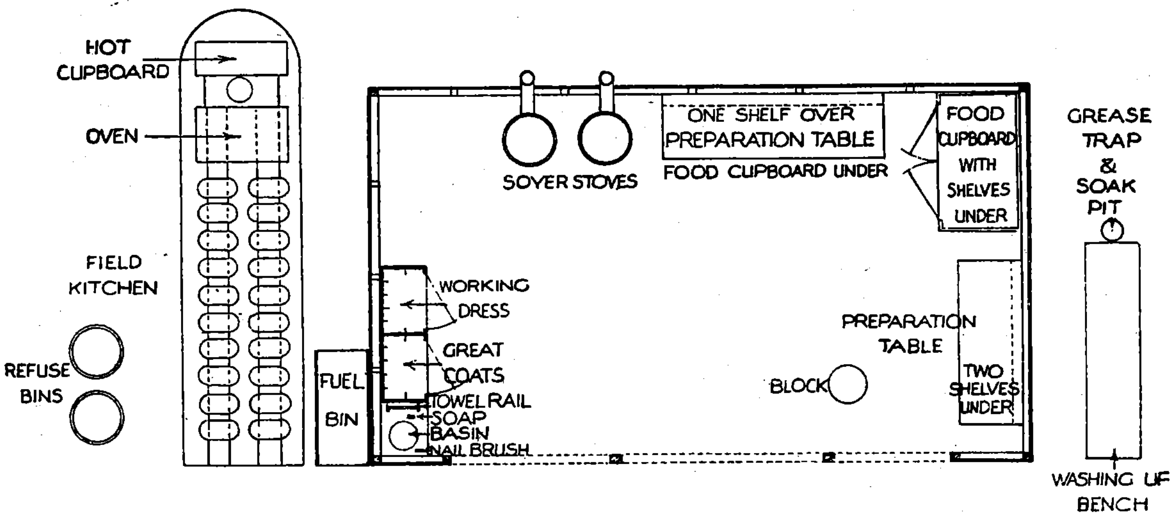
Standing camps of a semi-permanent nature are occupied during annual training in peace time, while on active service they are the usual form of quarters at a base or on the line of communication when troops are not accommodated in billets. Provision has to be made for prolonged occupation and the standard of comfort for the troops is therefore higher than is possible in temporary camps or bivouacs, as huts and other semi-permanent structures may be erected.

Accommodation is usually in huts and should allow the full 6 feet of wall space, 60 square feet floor space and 600 cubic feet air space for each man, as provided in barracks; for purposes of economy these amounts were reduced in huts during the Great War, but respiratory diseases became more prevalent. If bell tents are used, they should be provided with wooden floors and the number of men in each tent should not exceed ten (eight in the case of mounted units). The tent flaps should face away from the prevailing wind; the valances should be looped up every morning, all round in fine weather and at any rate on the leeward side if the weather is inclement. The ground beneath huts which are raised on plinths must be kept clean; the floor boards in tents should be taken up once a week and the ground cleaned and exposed to the air for at least one hour.

An organized water supply system should be established and the water laid on in pipes from a municipal supply or from specially bored or dug wells. To avoid extra expense of purification, a dual supply may be installed, one for drinking and cooking, and one for watering animals and ablution, but such supplies must be prominently labelled "DRINKING WATER" or "NOT FOR DRINKING"; this system is however often unsatisfactory and is not recommended. The area round standpipes should be cemented or paved with stones and drained to prevent waterlogging, while waste from dripping taps should be prevented.

Camp cookhouses should be shelters constructed of timber and corrugated iron with one side open and facing away from the prevailing wind; this type of cookhouse is less likely to be infested with flies than a closed building, unless the latter is fly-proofed. The floors should be concreted or rendered impermeable in some other way so that they can be kept clean.

Cookhouses for officers and serjeants are built on a scale of 4 square feet for each person on the ration strength, with a minimum of 100 square feet, while the scale for men's cookhouses is 35 square feet per 100 men with a minimum of 100 square feet.



GROUND PLAN

FIG. 21.—Camp cookhouse. (Semi-diagrammatic.)

Field ovens should be constructed to provide variety in the diet; there is no excuse for the troops having to suffer an unvaried diet of stew. Fly-proof cupboards or safes are required for the storage of food; chopping blocks, food preparation tables and receptacles for wet and dry refuse are also required, while close to the cookhouse there should be a washing-up bench with a grease trap and soakage pit.

Dining huts or marquees should be provided, as it is impossible to keep men's tents and their surroundings clean if men feed in their tents.

Latrines, ablution benches and other sanitary structures are usually of permanent construction and conservancy is carried out by contractors. This contract system in training camps, although otherwise satisfactory, unfortunately leads to lack of experience in practical sanitation amongst the sanitary personnel of units. The scale of latrine accommodation in standing camps is 5 per cent. up to a strength of 500, and 3 per cent for a larger number.

Perimeter Camps

A perimeter camp is one which is so situated from military necessity that the possibility of enemy action requires it to be enclosed within a defensive boundary; such camps are in constant use in outlying garrisons on the North-West Frontier of India. A suggested lay-out is shown in Fig. 22.

A perimeter camp usually consists of a walled camp surrounded by a perimeter of barbed wire entanglement, outside which is a defence area and outlying pickets, each picket being another perimeter camp in miniature. By night, and on an alarm by day, the perimeter is closed and the following points in the sanitation of such camps therefore require special consideration :—

1. The need for protection governs the choice of site, lay-out and details of the camp.
2. Inside the boundary wall there must be an open defence-concentration area and ample cross roadways, which must not be obstructed by sanitary structures.
3. All spaces for units are restricted and overcrowding may occur.
4. Sanitary appliances, except those essential for hospital patients or for night use, must be located outside the perimeter but within the defence area. Those required for night use may be placed in unit areas and their use necessitates great care to prevent the fouling of the ground; latrine and urine buckets should be used, but urine pits may be adopted if the ground is suitable.

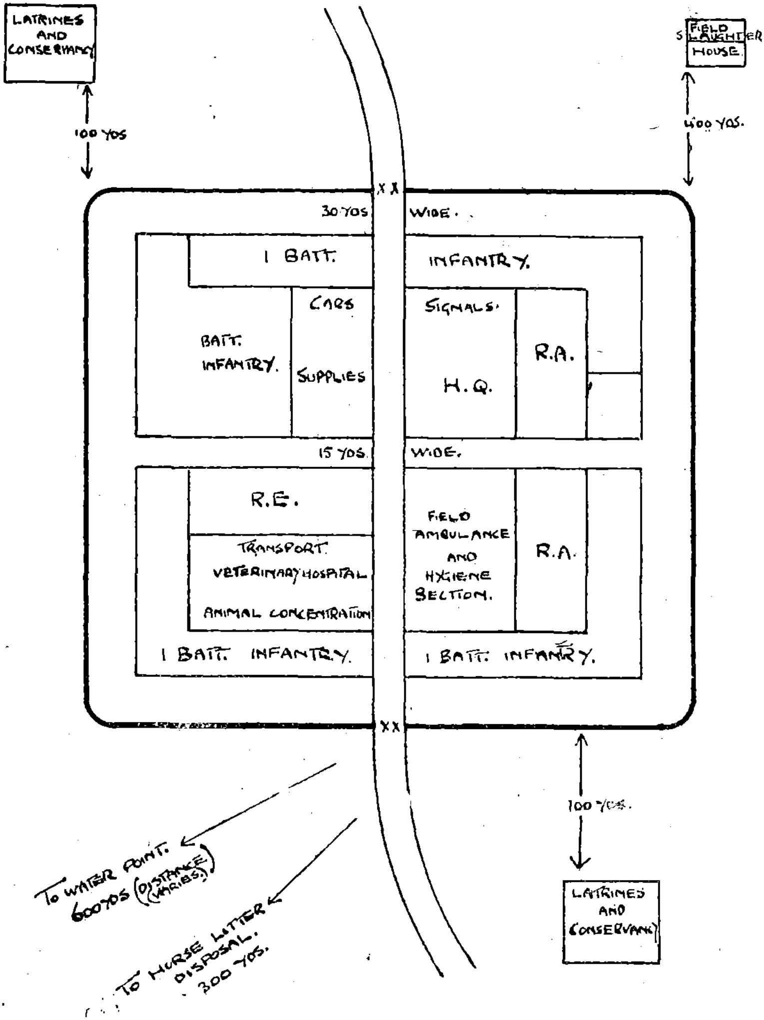


FIG. 22.—Schematic lay-out of a Perimeter camp.

NOTE—Above lay-out is intended to show General Sanitary Principles only.

P.636.—4.

5. A combined animal picketing area is undoubtedly the best.
6. The water point and ablution area are often at some distance outside the perimeter, and it may be possible to have temporary washing places inside the boundary wall, as well as those outside, if the soil is suitable for soakage pits.
7. The collection of refuse, litter and manure in the camp must be closely supervised and their disposal carried out in a special conservancy area outside the perimeter; otherwise the camp will soon be plagued with flies.

Sanitation in Trenches

Trench shelters and dugouts are used in a protracted defence; their prolonged occupation is trying to the health, and sanitation presents many difficult problems which must be overcome if the health of the troops is to be maintained. The trenches should be well drained and "duckboards" provided.

Attention must be paid to the ventilation of dugouts, and this presents special difficulties when gas-proofing is a necessity; there is special danger of carbon monoxide gas poisoning when lighted braziers are used in dugouts.

Ratproof food safes, improvised from tins, should be provided and all food refuse should be stored in ratproof receptacles until removal is possible. Sandbags should be hung up at convenient points in the trenches for the reception of rubbish and no refuse of any kind should be thrown over the parapet. Every effort must be made to keep the trenches and dugouts clean, and conservancy arrangements must not be neglected.

Conservancy in the trenches must necessarily conform to the military situation; the burning of excreta and refuse is usually out of the question and a system of burial has to be adopted. Where the level of the ground water permits, deep trench latrines may be used, but, when the water level is high or there is any risk of flooding, receptacle latrines with fly-proof covers must be used and the contents of such receptacles must be buried in pits, well away from occupied trenches and dugouts, and on no account thrown into shell holes or other convenient hollows. Special care must be taken with regard to latrines in communication trenches; such latrines are in constant use by men of different units and there is a tendency to neglect them and to disclaim responsibility.

From the tacts stated in this chapter it will be realized that sanitation in the field is often a question of temporary improvisation, but nevertheless the objective is to attain a standard as near to that of good barrack sanitation as the circumstances permit.

Building materials are frequently difficult to obtain for the construction of sanitary appliances, but this must not be used as an excuse for not providing them ; much can be done with empty boxes, tins, wire and other scrap or salvaged materials and by the employment of forethought and ingenuity, and the intelligent application of sanitary principles.

CHAPTER VIII

FIELD SANITARY APPLIANCES

The types of sanitary appliances used under the varying conditions of service, other than in barracks, will be described in this chapter. Resulting as they do from improvisation and devices designed to meet special circumstances and made from material at hand, such types are very numerous and it is impossible, and unnecessary, to describe all of them. The present aim is to describe a few relatively standard types which have been proved efficient and the descriptions and details of which it may be possible to adopt, or, which is more probable, will serve as sound guides for the provision of appliances for similar purposes.

Details of the appliances described, with exact measurements, and quantities of materials required, are given in Appendix 18.

Disposal of human excreta

Human excreta should be deposited direct into the ground whenever possible; otherwise it should be burnt or buried. When incineration is adopted, solid matter (fæces) should be burnt in closed incinerators or destructors, a good supply of fuel and careful stoking being necessary to ensure that the fæcal matter is completely burnt.

The alternative to burning is removal and burial, which is usually carried out by contractors. When this system is adopted, the material awaiting removal must be kept in covered metal receptacles or emptied direct into the vehicles in which it is to be removed; such vehicles should be specially constructed for the purpose, *e.g.*, the Crowley cart. Removal must be carried out in daylight and at regular intervals to a site sufficiently distant so that it will not be a danger or an offence to the camp.

The average daily production of fæces is about 5 ounces per man, which is equivalent to 31 pounds or $\frac{3}{4}$ of a cubic foot per 100 men.

Urine should always be disposed of directly into the ground, unless digging is impossible or there is danger of contaminating the water supply, when removal and burial may have to be adopted.

The average daily production of urine is 50 ounces per man or 30 gallons per 100 men.

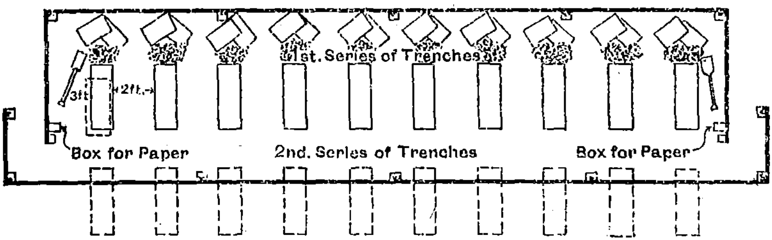
Latrines

Latrines should be sited to leeward of the camp and in such a position that no fouling of the water supply can result. They should be removed as far from the area occupied by the men as is compatible with convenience and in any case should not be less than 100 yards distant from kitchens and places where food is stored.

Whenever circumstances permit, all excreta should be disposed of direct into the ground, as this obviates removal, and therefore possible fouling of hands and ground by very dangerous material. Special latrines must be provided for Indian troops and followers.

Three types of latrine are in common use in the field :—

1. The shallow trench latrine.
2. The deep trench latrine.
3. The bucket latrine.



Trenches—3 ft. long, 2 ft. deep, 1 ft. wide, 2 ft. apart.

FIG. 23.—Shallow Trench Latrine.

1. The shallow trench latrine is not satisfactory and should only be used for short halts, bivouacs and temporary camps of at most three days' duration.

The trenches are dug in rows allowing 5 for the first 100 men and 3 for every additional 100. Each trench should be 3 feet long, 1 foot wide and 2 feet deep with the sides slightly undercut, and a space of 2 feet should be left between trenches; the turf from the surface should be removed carefully and placed behind each trench while the excavated earth should be piled between the turf and the trench.

The latrines should be surrounded by a canvas screen and, if necessary, a shallow drain should be dug to divert surface water from the trenches and to keep the area dry.

When using shallow trench latrines men should squat astride the trenches; if they are used in this way, there should be no fouling of the surrounding ground. Before leaving the

latrine, each man should cover his own excreta with earth from the pile in the rear of the trench, and for this purpose scoops, tins or spades must be provided at each trench; on no account must men shovel earth into the trench with their feet as this leads to fouling of their boots.

The trenches are filled in after twenty-four hours' use or when the contents are within six inches of the top. The contents should be covered with pieces of oiled sacking or oiled paper. The earth remaining from the excavation of the trenches is then replaced, the turf put back in position and the whole rammed down tightly. Before the previous day's trenches are filled in, another row, arranged in the same way, should be prepared in front of the previous row, that is, nearer the camp.

The successful working of shallow trench latrines and the prevention of access of flies to the excreta can only be obtained if all excreta is covered as soon as it is passed. This is often difficult, because the pile of earth is inconveniently placed, a sufficiency of scoops or spades is not always available and the unpleasant surroundings induce men to leave the latrines as soon as possible. Men must be educated to realize the importance of covering their excreta, and close supervision by regimental sanitary police must be maintained to ensure that this is done.

2. Deep trench latrine.—The old type of deep pit latrine, with a pole across to sit on, should never be used, as it is conducive to fouling of the sides of the trench with urine and fæces and permits the access of flies to the excreta and thereby the transference of disease germs to the food of healthy persons.

The fly-proof deep trench latrine is a good type and should be used in all camps of four or more days' duration, wherever the level of the subsoil water permits.

The trench is dug 6 to 8 feet deep, 3 feet wide and 10 feet long; the sides should be vertical, and, where the soil is liable to collapse, they should be revetted with timber, corrugated iron or sandbags. Such a trench will provide room for five seats and seating accommodation should be provided on the scale of 5 seats for the first 100 men and 3 for every additional 100.

A fly-proof superstructure should be provided for the seating. It should be made of well-seasoned tongued and grooved timber and have vertical sides and ends but a sloping back; the openings should have lids made of metal on wood frames and attached in such a way that they close automatically when not supported, while under each opening and in front a metal shield should be placed to deflect urine into the middle of the pit.

Before the fly-proof cover is placed in position over the trench, the ground surrounding the trench for a distance of four feet should be dug up to a depth of six inches, the loose earth removed and a layer of oiled sacking spread over the whole area, with the ends turned down over the sides of the

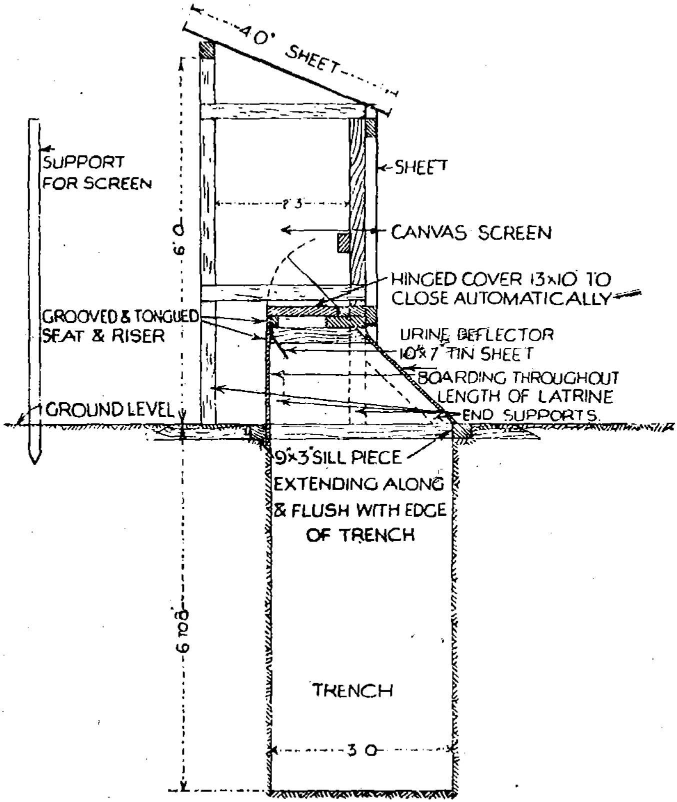


FIG. 24.—Deep trench latrine.

trench. The fly-proof cover is then placed in position, being supported by two heavy battens along the front and back of the trench and extending beyond it for a distance of two feet at either end. The loose earth is mixed with heavy oil, spread over the sacking and beaten down, thus forming a trap for any fly maggots which may hatch out in the trench. Care

must be taken that no wooden supports cross the trench under any of the seat openings, or fouling will occur. A portable type of cover may be constructed to fold flat for transport.

The latrine should be surrounded with a canvas screen or other temporary structure and, if a roof is provided, the lower edge must project well clear of the trench. A "duck-board" should always be placed along the front.

Disinfectants should never be used in these trench latrines, although the seats should be cleaned periodically with cresol; a handful of bleaching powder put in through each opening morning and evening acts as a fly deterrent without interfering with the digestion and liquefaction of the excreta which goes on in the trench.

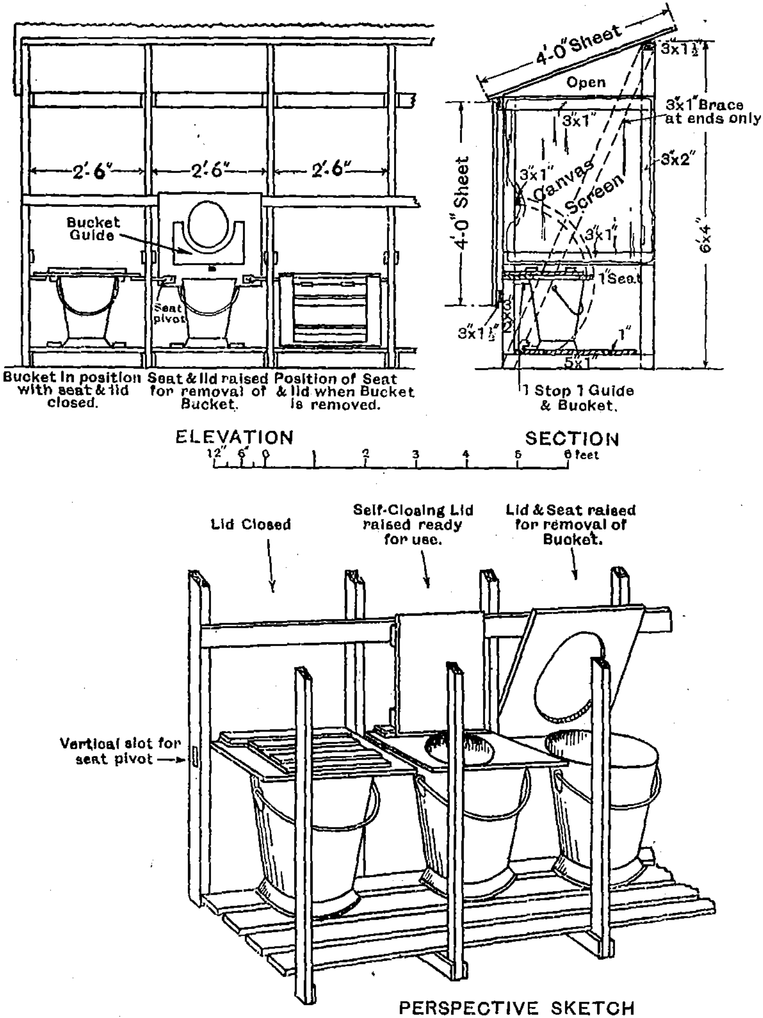
When the trench becomes filled to within three feet of the top, the cover should be removed to a new trench, previously prepared, the contents of the old trench then covered with oiled sacking and the trench filled in with earth and prominently labelled.

3. Bucket latrines.—A system of bucket latrines is essentially one for use in standing camps, billeting areas, railway stations and other places where trained sanitary staffs are available, although they may be necessary where deep trench latrines cannot be used. Such latrines can readily be improvised, but they must be fly-proofed and fly-proof receptacles must be available into which the contents of the buckets can be emptied for removal.

Bucket latrines should be erected on an impermeable base which should drain into a covered sump or soakage pit. The seats, on a scale of 5 per cent., with extra ones for serjeants, should be fitted with fly-proof self-closing lids and the buckets, or other receptacles, which should be coated inside and out with crude oil to keep away flies, should fit accurately under the seats and be retained in position by guides or stops.

The contents of the buckets may be disposed of (*a*) by incineration, (*b*) into an Otway pit, or (*c*) by removal by a contractor. If disposal is to be by incineration, litter should be placed in each bucket before use; when the bucket is removed after use, the urine should be poured off through a strainer into a soakage pit and the remainder of the bucket contents, with addition of more litter or dry refuse, emptied directly into the incinerator, which should be situated close to the latrine. The mixing of fæces and litter on platforms open to flies must not be allowed.

It is usually found that men resort to the buckets nearest the entrance with the result that these buckets become filled to overflowing; the regimental sanitary detachment should



NOTE:- The guides & stops to Buckets should be so arranged that the seats & lids fit accurately over the Buckets and should be fly-proof.

FIG. 25.—Bucket latrines for a standing camp.

ensure that this is not allowed to occur and that buckets are removed when three-quarters full.

Buckets should be thoroughly cleaned with cresol solution, 2½ per cent., as soon as emptied, and should then be smeared inside and out with heavy oil. The cleaning should be performed on a concrete platform provided with a soakage pit.

To prevent fouling under the seats, extra buckets must be available to replace those removed for emptying.

A supply of latrine paper should always be available with every variety of latrine, and latrines should be lit at night.

Latrines for Indian troops and followers

While it is especially important in the tropics that attention should be paid to the fly-proofing of latrines, many difficulties arise from the habits and prejudices of the races concerned, and consequently any measures adopted are apt to be frustrated.

The usual type of latrine for Indians consists of a metal receptacle (14 inches by 9 inches by 6 inches) placed between two low platforms on which the man places his feet while squatting over the pan; sometimes two receptacles are used in an attempt to keep the urine and fæces separate.

Where such latrines are in use, the sweeper employed at the latrine must be taught to empty the pans immediately after use, the urine being poured into a soakage pit and the remainder of the contents emptied into the incinerator.

It is possible to get Indian troops to use deep trench latrines in which the trench is covered by a flat platform with narrow openings and self-closing lids so arranged as to permit of squatting, but sometimes caste prejudices interfere with the adoption of this type of latrine.

Abdast

Indians do not use latrine paper, but cleanse themselves with water after defæcating, and therefore, to prevent fouling of the ground, it is necessary to provide an "abdast," or washing platform, near any latrine for Indians. The washings from the platform, being dilute sewage, should be drained into a covered soakage pit.

Otway's pit

This form of pit is used for the disposal of the contents of latrine buckets or of bedpans used in hospitals; it is also an anti-fly measure.

A pit 10 feet long, 3 feet wide and 6 to 8 feet deep is dug on a site where the level of the subsoil water permits and

where there is no danger of contaminating any water supply; it is covered with a stout timber cover, on which oiled sacking is spread to make it fly-proof and light-proof. A hole is left at one end of the cover and into this is fitted a metal dustbin, or other metal box, with the bottom cut out to form the inlet by which excreta are emptied into the pit; the bin, or box,

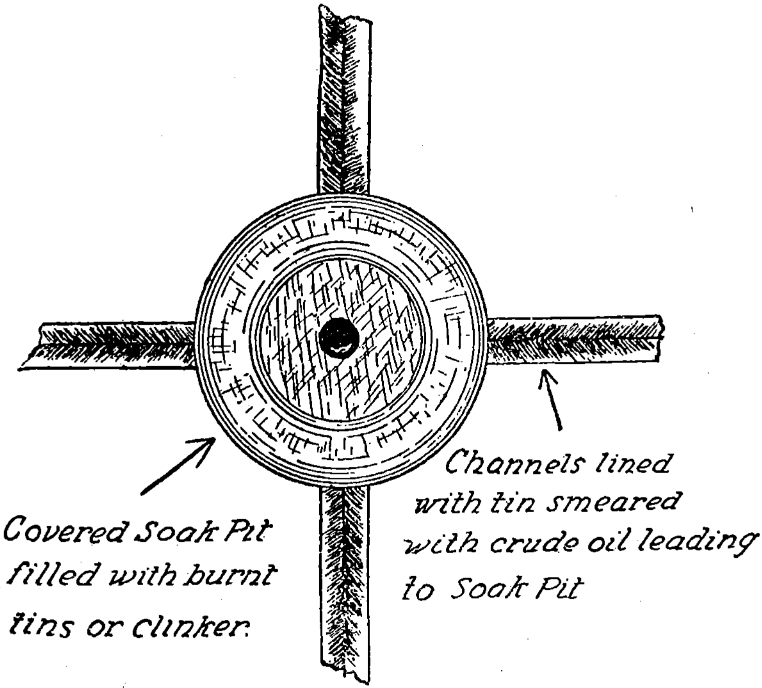


FIG. 26.—Abdast.

must have a well-fitting lid. At the other end of the cover is a hole, six inches in diameter, and over this hole is placed a box fly-trap. The only means of entrance of light into the pit is through the hole under the fly-trap; newly hatched flies make for the light and are thus caught in the trap. Such a pit acts as a form of septic tank and lasts for long periods.

Urinals

Shallow trench urinal

In temporary camps and bivouacs, shallow trench urinals may be used as a purely temporary measure. The urinal consists of a trench 10 feet long, 3 feet wide and 6 inches deep with the soil in the bottom loosened for a further six inches. The excavated earth is piled on three sides and is used to refill the trench when it is closed. One such trench urinal should be provided for every 250 men.

Trough urinal

This is the best type of field urinal for day use. It is made of corrugated iron or plain galvanized iron in the form

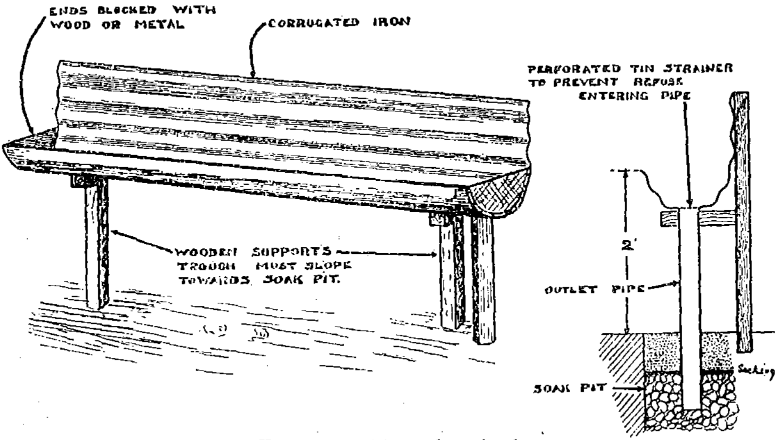


FIG. 27.—Trough urinal.

of a trough with a high back. The trough is raised on wooden supports so that the front is two feet three inches from the ground with a slight fall to a pipe leading into a soakage pit; the ends of the trough should be closed.

One trough, 8 feet long, is required for every 100 men.

Funnel urinal

A soakage pit, 4 feet by 4 feet by 4 feet, is dug, filled with stones and covered over. Four metal conical funnels, or pipes with expanded tops, are built into the corners of the pit and some form of strainer is placed in the mouth of each funnel to hold back paper, cigarette ends or other articles likely to

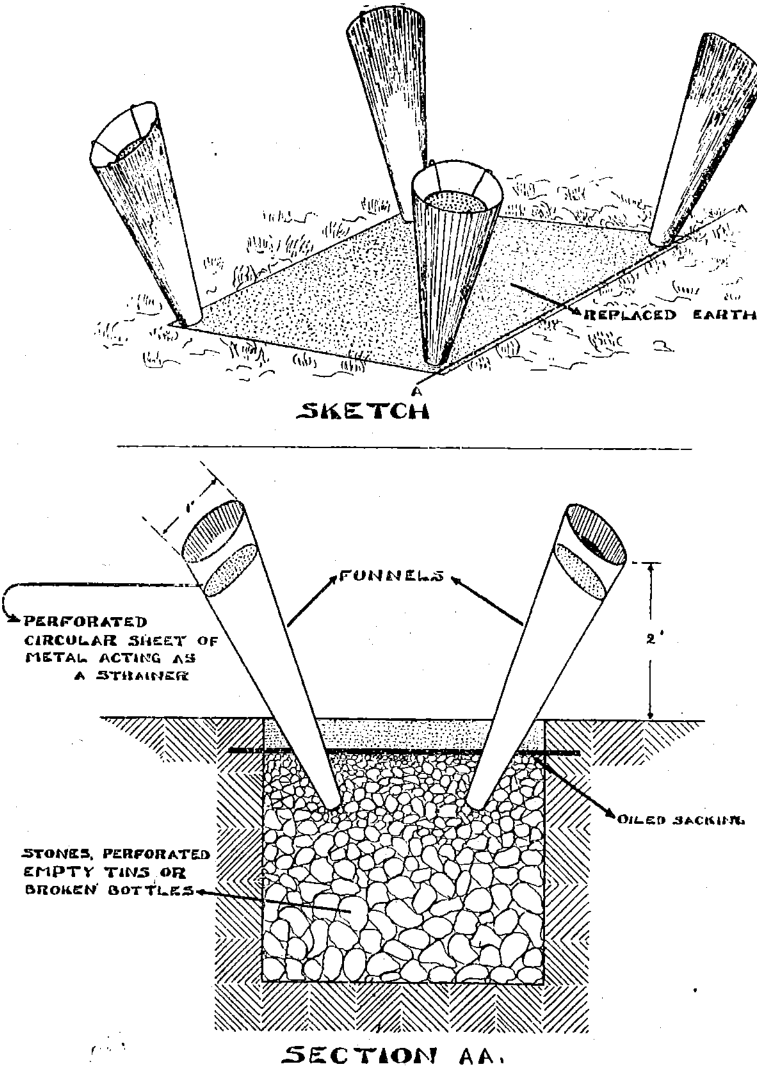


FIG. 28.—Funnel Urine Pit.

cause blockage. The mouths of the funnels must be large and not higher than 2 feet 3 inches from the ground. Single funnels, placed in small pits at the ends of the tent lines, or near canteens and mess tents, are a suitable type of night urinals in camp.

Bucket urinal

Buckets, or other metal receptacles, are placed on a suitable platform and removed periodically so that the contents may be emptied into a soakage pit. Bucket urinals may be used in conjunction with bucket latrines, but there is little to recommend them for camp use, as spilling is a common occurrence.

Indian troops and followers normally adopt the squatting position when urinating, and urinals may have to be modified for their use, although they can soon be taught to use urinals in the standing position.

Disposal of manure

Horse, mule and camel dung and stable litter form the favourite materials for fly breeding and are often present in large and ever-increasing amounts at times when fly breeding is greatest.

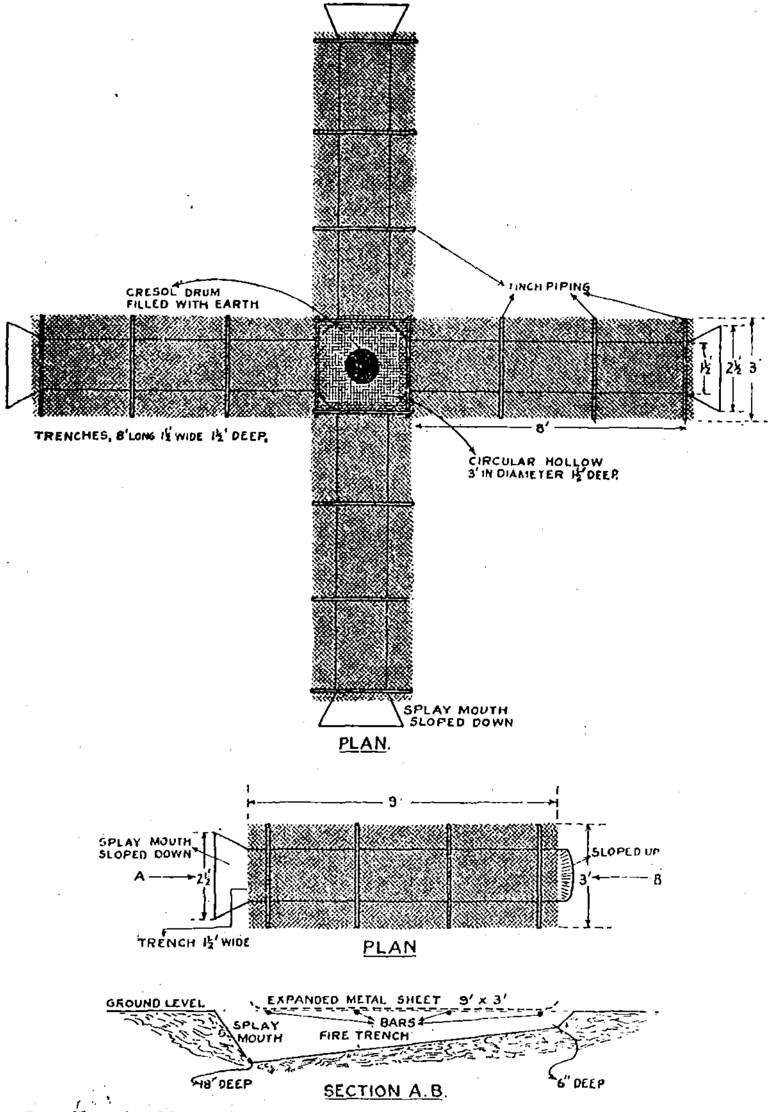
The methods of disposal are burning, tight-packing, spreading or removal by contractors.

Burning

Single trench manure incinerator.—In its simplest form this consists of a single trench 9 feet long, 1½ feet wide, 6 inches deep at one end and 1 foot 6 inches deep at the other end, the mouth of which is splayed out. The trench is covered with expanded metal measuring 9 feet by 3 feet. With the help of an oil and water flash fire a trench of this size will burn the litter from 50 horses in a day.

Cross trench incinerator.—This is similar to the single trench type, but consists of two trenches crossing at right angles; the expanded metal covering the centre portion must be supported.

Basket and cradle incinerators.—Both may be made from baling wire or hoop iron woven into flat sheets, which are then wired together to form either a rectangular basket or a V-shaped cradle. The basket pattern is raised off the ground on four tins or other supports, while the cradle type is suspended apex downwards from upright supports, from which it can be made to swing and thereby increase the draught; the latter pattern is useful in Eastern countries where native labour is available for swinging the cradle.



Cross Trench: *Materials used.*—Expanded metal (2-in. mesh): for trenches, 4 pieces of 9 ft. by 3 ft.; for centre, 1 piece of 3 ft. by 3 ft. 1 in. piping, sixteen 3-ft. lengths. 1 cresol drum.

Single Trench: Expanded metal (2-in. mesh): 1 piece size 9 ft. by 3 ft. 1 in. piping, four 3-ft. lengths.

FIG. 29.—Trench manure incinerator.

In dry climates, where manure can be dried, the mesh should not be more than one inch; elsewhere a two-inch mesh will suffice.

These incinerators are useful also for burning refuse and, if made in different sizes, they can be nested together; they are then convenient for transport and form a valuable addition to the sanitary appliances of a unit on the move under field service conditions.

The soil under these incinerators should be dug up, oiled and rammed in to prevent fly breeding.

Tight packing

When military necessity, or excessive moisture, prevents the burning of manure, it is best disposed of by tight packing.

The success of this method depends on the fact that the heat developed in fresh and fermenting manure, when tightly packed, will kill any fly maggots which may hatch out in the manure. Manure that is tight packed does not lose its value as manure.

There are two varieties of the method:—

1. A piece of ground 9 feet wide, and of such a length as may be required, is treated with heavy oil (1 pint to the square yard), or beaten hard, and trenches 1½ feet wide are cut round the plot. Fresh manure is piled on the area and beaten down hard during packing; the top is flattened, the sides and one end sloped down to the trenches and then the earth dug from the trenches is puddled with water and plastered all over the heap to form a layer 4 to 6 inches thick, beaten down and allowed to dry. Further additions of manure are placed on the open end and treated in the same way. When the dump reaches a length of twenty yards, a trench is dug across the open end, which is then closed, and the whole dump left until fermentation ceases. The dump should be railed off on three sides to ensure that manure is added only at the open end.
2. An impervious platform of concrete, or oiled and rammed earth, 18 feet wide, and as long as may be required, is prepared. Commencing at one end the manure is packed tightly on this platform leaving an area of 4 feet clear all round. Oiled sacking is placed under the edges of the pile and carried up the sides. When a height of 5 feet is reached, the top is flattened and beaten down hard. Fresh manure is added at one end only and the remaining three sides are fenced off. On the 4th day the top 6 inches are stripped off and buried in the fresh manure; this is continued daily.

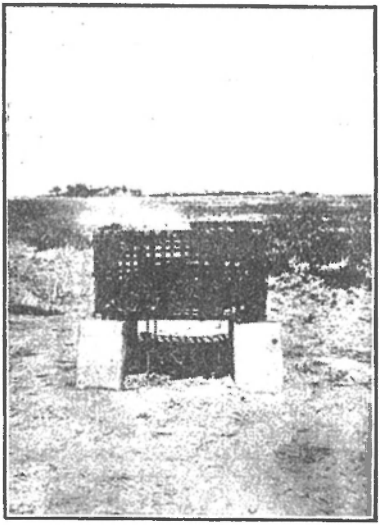


FIG. 30.—Basket incinerator.

Spreading

In dry weather, especially in hot countries, manure may be spread out to dry and thus made to lose its attraction to flies.

The drying ground should if possible be oiled and rammed and marked out into four areas, which should be used in rotation, each being sufficient for one day. All lumps in the manure should be broken up, the manure spread out evenly to a depth of not more than two inches and raked over daily. When dry, the manure is raked into heaps, which are set alight

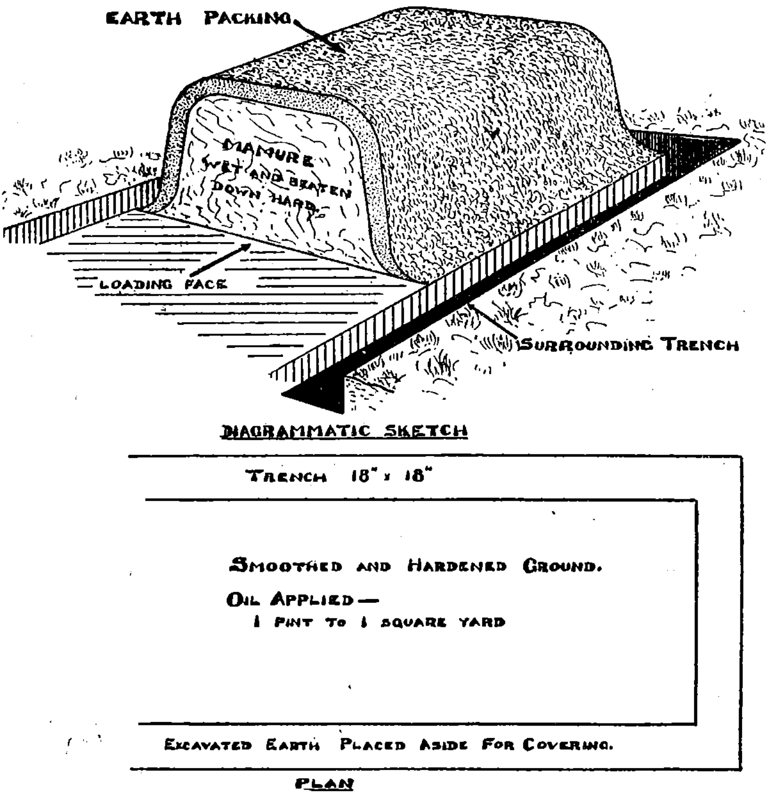


FIG. 31A.—Tight packing of manure. Using a trench.

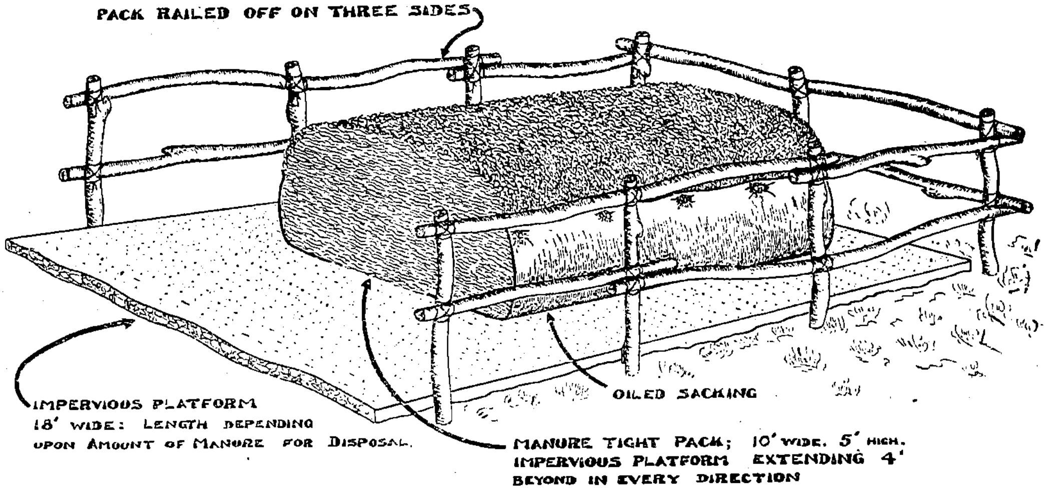


FIG. 31B.—Tight packing of manure. Using sacking.

on the windward side; instead of being burnt the manure may be spread on riding tracks or used for road making.

Road making.—In desert or sandy areas manure becomes filled with sand and is then difficult to burn. When used for making roads, the manure is thoroughly dried and spread to a depth of 9 inches.

Removal by contractors

Although this is a convenient and often profitable way of disposing of manure, it is most liable to break down at the most difficult time, namely in wet weather.

Arrangements for collection must be thorough, while removal must be regular, complete and to such a distance that fly breeding will not affect the camp.

Cow dung

The disposal of cow dung presents no difficulty, as it forms excellent fuel when made into "dung-cakes" with chopped straw and allowed to dry.

Disposal of Liquid Refuse

Water from cookhouses contains a considerable amount of fat in the form of grease, while water from ablution places and baths contains soap. No soil, however porous, will absorb for any length of time water containing fat or soap, and these must be removed before the water reaches the soil, which otherwise will become clogged. Mechanical and chemical methods are used for removing the fat, soap and other suspended matters in the waste water.

Cold water grease traps

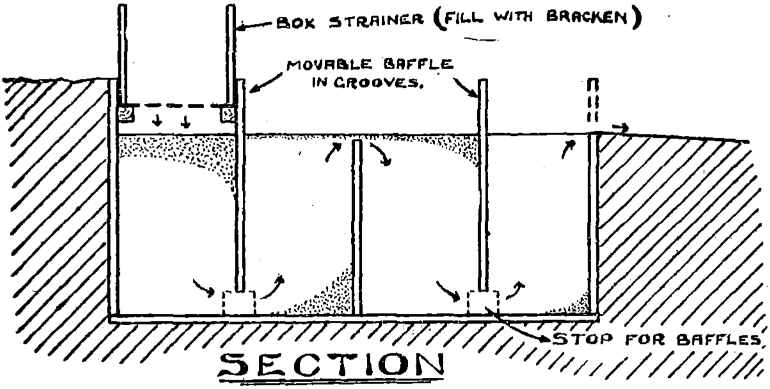
If hot water containing fat is run into an adequate amount of cold water, the fat solidifies, rises to the top of the water and can be skimmed off; this is the principle on which the cold water grease trap is constructed.

The hot water inlet must be baffled, either by a submerged vertical inlet or by a baffle plate (*see* Fig. 32); this baffle plate prevents the entering water from disturbing the layer of grease which forms on the surface of the water in the body of the trap. The exit from the trap is similarly baffled to prevent the effluent carrying off the layer of grease. A floor baffle plate is essential to check the direct flow of water from inlet to exit, and this also serves to keep back sediment in the trap. The grease trap should be fitted with a fly-proof cover.

The size of the trap should be such that the amount of cold water in the trap is five times as great as the amount of hot greasy water likely to be added at any one time.

In barracks, where washing-up sinks are in use, the capacities of the sinks discharging into the trap can easily be ascertained and an accurately sized trap be constructed. Where the sinks, instead of discharging by means of plug holes, are allowed to discharge small quantities continuously over overflows, the capacity of the trap should not be less than six times the volume of the flow discharged per minute; for example, if the overflow is at the rate of one gallon per minute, the grease trap should have a water capacity of at least six gallons.

3 Baffle Plates.



Minimum size of container 50 gallons or $2' \times 3' \times 1\frac{1}{2}'$.

FIG. 32.—Cold water baffle plate grease trap.

In camps, where washing-up sinks are not available, a minimum size trap capable of holding 50 gallons of water should be used; should it be found that the water in the trap is becoming too warm, and that the grease is not solidifying, a second similar trap should be constructed and connected with the first trap so that the water passes through both traps.

Cold water traps may be made in the form of a wooden box or of concrete, with wooden or metal baffle plates.

In the management of a cold water grease trap, tea leaves and food debris from the plates should be removed before washing-up, and, if soda is used when washing-up, little or no grease will be recovered from the trap. The trap should

receive regular attention, once or twice weekly. Inefficiency of the trap results if skimming, emptying and cleaning out are not performed often enough.

Where it is desired to salvage the grease for sale as a by-product, the greasy scum from the trap should be boiled down in a suitable receptacle kept for the purpose ; when allowed to cool, a cake of grease will be found on top. The greasy scum may be mixed with cinders, etc., and burnt in the incinerator, or it may be buried. The sludge recovered from the bottom of the trap should be buried.

Strainer trap

A simple strainer through which the waste water passes may be used either alone or in connection with cold water grease traps, *see* Figs. 32 and 33.

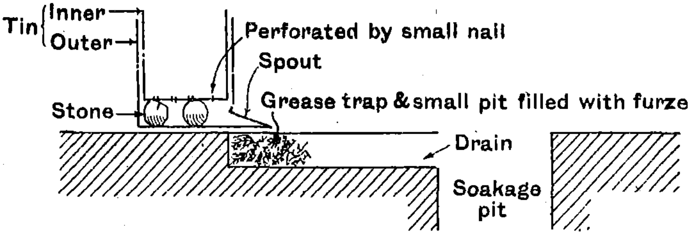


FIG. 33.—Strainer grease trap for temporary camps.

Grass, straw, bracken, furze or similar materials will keep back some of the grease, soap and suspended matters. The weight of a few large stones pressing down the grass, etc., greatly assists its efficiency, *see* Fig. 33A. The straining material should be removed daily, or more often if clogged, and burnt.

A simple type of strainer trap, suitable for bivouacs or camps of short duration, consists of a small soakage pit, 1 foot square and 6 inches deep, connected to a soakage pit by a channel 3 feet long, 6 inches wide and 6 inches deep. The small pit and channel are packed tightly with grass or similar material.

A more elaborate type, suitable for temporary camps, consists of a perforated tin, containing the straining material, fitted into another tin, and the whole connected to a soakage pit by a channel which also contains straining material.

Chemical methods

Although by the use of the cold water and strainer traps it is possible to remove much of the grease from washing-up water and some of the soap from ablution water, it is necessary to resort to chemical treatment where it is desired entirely to remove these matters, *e.g.* in permanent camps not fitted with a water-carriage system.

Alum, alumino-ferric, lime, ferrous sulphate and bleaching powder are the usual chemical precipitants which may be used for this purpose. It is necessary to provide a tank in which the chemical and water are mixed ; the mixture is then allowed to stand and the solid matters settle as sludge at the bottom of the tank, leaving a clear effluent above. Instead of being

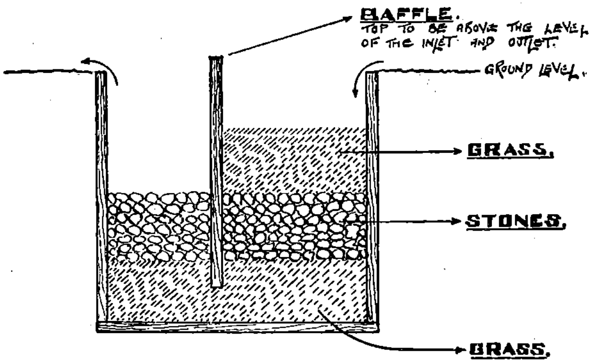


FIG. 33A.—Strainer trap.

allowed to settle, the mixture may be passed through a strainer trap in which the sludge is held back by grass, etc., a box with a single central baffle plate may be used, *see* Fig. 33A, and layers of grass and stones placed on both sides of the baffle plate ; bleaching powder, sufficient to make a 0·1 per cent. solution, may be used with this form of trap.

The most efficient chemical method is the use of ferrous sulphate and lime, and the details of this method are given in Appendix 12.

Final disposal of waste water

When a water-carriage system is available, as in barracks and some permanent camps, the waste water, after passing through the cold water grease trap, enters the drains, as does

also the ablution water. In camps without a water-carriage system, the water must finally be disposed of in the ground. It may be run into a convenient water course provided that there is no danger of contaminating a drinking-water supply. Channels through sand or gravel allow of soakage and filtration and are therefore preferable.

As a rule, it is necessary to resort to artificial pits for the disposal of waste water and the best method is by means of soakage pits.

Soakage pits

A pit should be dug 4 feet by 4 feet by 4 feet; if more soakage area is required, further pits of the same size may be dug, as a pit of this size is most conveniently dug by one man. The pit is filled up to within 6 inches of the surface of the ground with stones, rubble or burnt-out tins, which should be perforated. The pit should be covered with brushwood or sacking, over which earth is placed.

The small amounts of grease and soap which still remain in the water after mechanical attempts to remove these will ultimately form a coating on the sides and floor of the soakage pit and prevent further absorption of water. It is wise, therefore, to have reserve pits available, and in clay soils where absorption is very slow this precaution is most necessary.

Soakage pits should be provided at each cookhouse, and also at ablution places and bath-houses.

Herring-bone drainage

This method may be employed for the disposal of waste water from ablution places and bath houses, or when the level of the subsoil water is so high that soakage pits cannot be used.

A series of connecting channels, 1 foot wide and 1 foot deep, are dug in a herring-bone pattern so that the different sections can be used alternately. The water evaporates and also soaks into the soil, and to ensure good soakage the sides of the channels should be cleaned and the earth in the bottom loosened periodically.

Surface evaporation

In ground where soakage is impossible, water may be evaporated by running it into a series of shallow earth pans, 15 to 20 feet square, which are used in rotation. This method can only be used in hot dry climates.

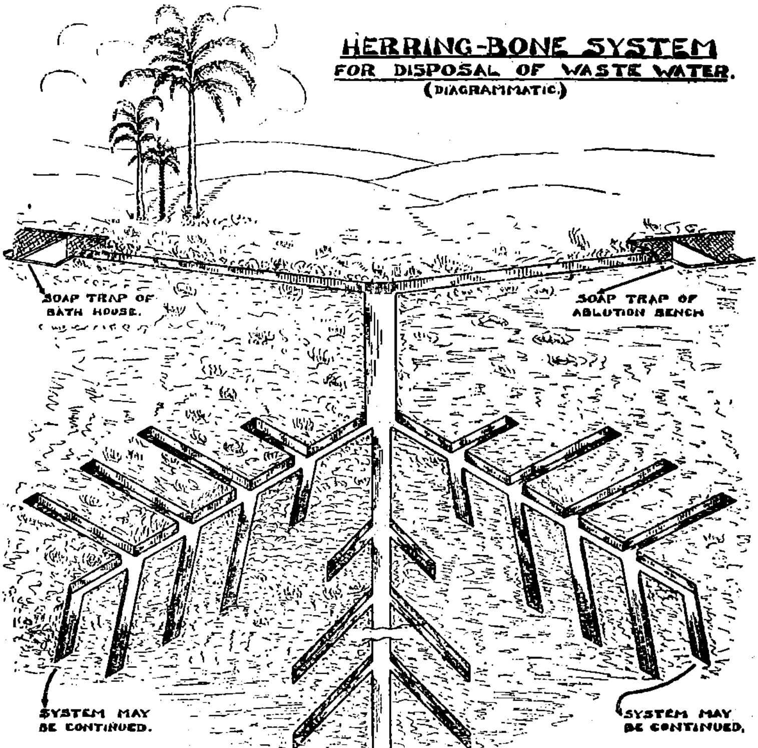
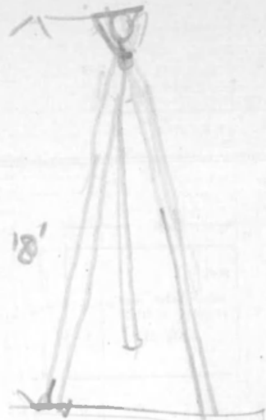


FIG. 34.—Herring-Bone System for Disposal of Waste Water (Diagrammatic).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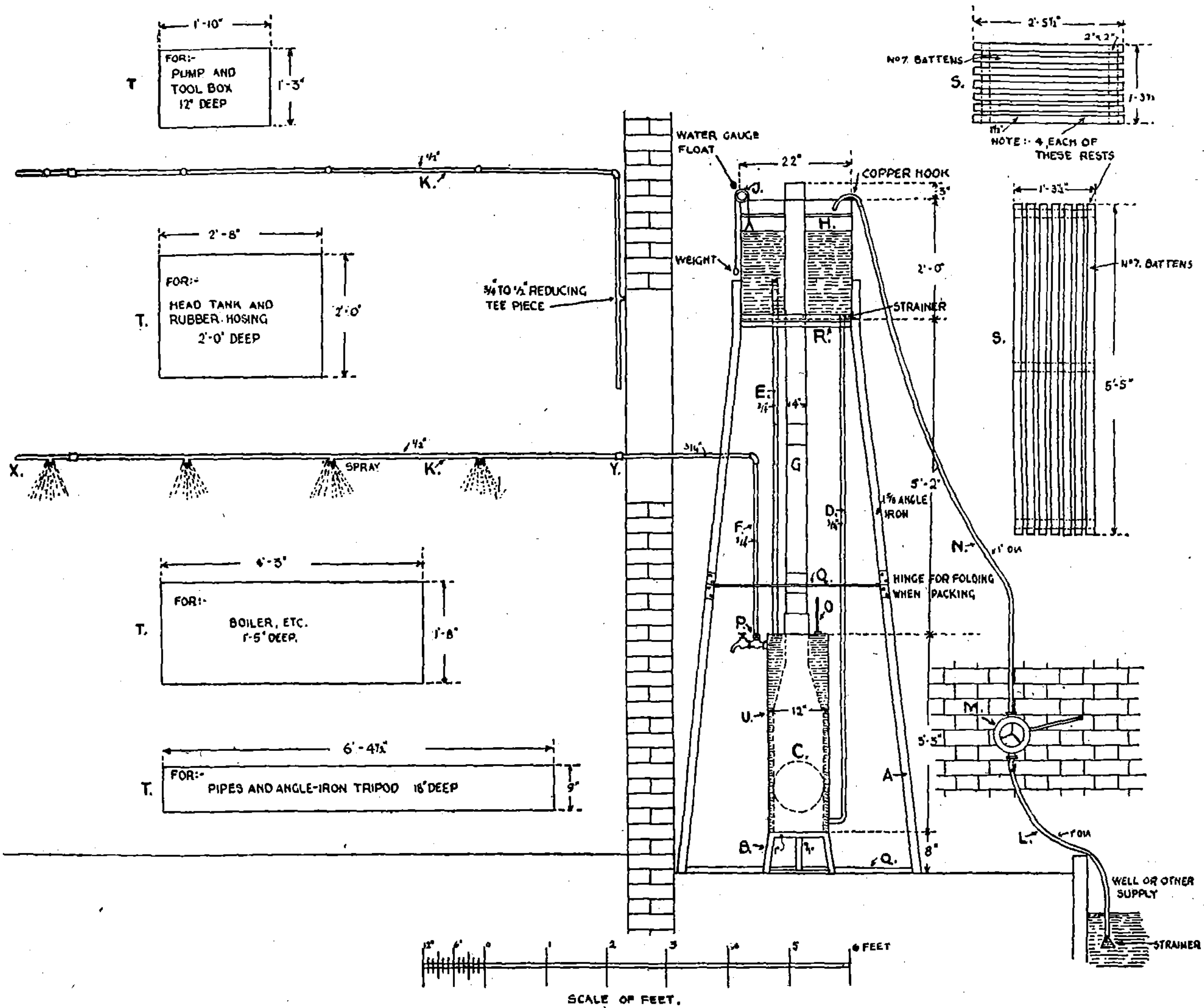

Fig. 36.

SECTIONAL DRAWINGS OF TRANSPORTABLE SHOWER-BATH.

A. Large iron tripod.
B Small iron tripod.
C. Furnace.
D. Return pipe, ¾ inch, leaving bottom of cistern, entering lower end of boiler.
E. Flow pipe from top of boiler, entering cistern at 8 inches from bottom.
F. Iron pipe, ¾ inch, from top of boiler to sprays.
G. Chimney, in 3 movable parts fitting into one another.
H. Cistern, galvanized iron tank holding about 26 gallons of water.
J. Float, pulley and lead attached to cistern registering depth of water.
K. Spray piping with 8 sprays.
L. and N. Two lengths of hose.
M. Semi-rotary pump.
O. Thermometer.
P. Pipe fitted with 2 cocks, a shut-down for cutting off the sprays, and a draw-off bib cock for emptying cistern.
Q. Tripod kept in position by 3 round tie rods.
R. Triangular piece, fits into mortice 1 inch from top: on this the cistern rests.
S. Footboards or footrests.
T. Dimensions of four packing cases.
U. Water jacket or boiler.

Ablution and Bathing

Ablution benches

The construction of the type of ablution bench recommended for use in camp is shown in Fig. 35. One double-sided bench, 9 feet long, is required for every 50 men. Duck boards or gravel standings should always be provided.

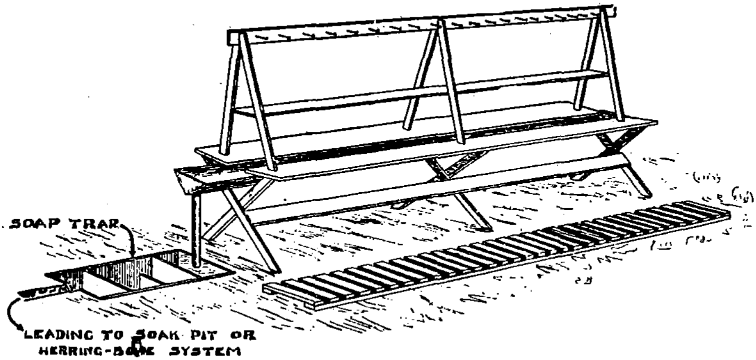

FIG. 35.—Ablution bench.

Baths

Facilities for bathing should be provided if possible. If the weather permits, bathing pools may be formed in streams. Transportable shower baths provide the most desirable type of field bathing installation (Fig. 36).

Disposal of dry refuse

All refuse should be burnt whenever possible; if it cannot be burnt, it should be buried deeply in a pit, care being taken that fresh additions are covered immediately, and the pit, when full, covered with well-rammed earth mixed with heavy oil. Circular pits, 2 feet in diameter, may be used in bivouacs for one night only.

All refuse should be collected in bins, or receptacles improvised from oil drums or biscuit tins, which should be provided with covers and placed in conspicuous places on suitable raised stands (Fig. 37).

Incinerators

An efficient incinerator is one of the most necessary sanitary appliances for camps. Many types have been devised, but they all belong to one or other of the three groups, namely open, closed or semi-closed.

Closed incinerators are the most efficient, especially for wet refuse and fæces, and should be adopted in standing camps. In temporary camps, there is usually not the time or material for erecting one of the more substantial varieties of closed incinerator, and some form of rapidly and easily constructed open or semi-closed incinerator should be provided.

The main principles involved in the construction of an incinerator are (*a*) a free supply of air, and (*b*) conservation of heat; on these, together with efficient stoking, depend the successful working of all types.

The following are essential points in the construction of incinerators :—

1. The incinerator should be built on an impervious base of concrete or hardened earth.
2. The air inlets must be ample and should be funnel-shaped, narrower on the inside, to produce a blowing effect.
3. The fire bars should be placed loosely on their support rather than fixed.
4. The stoking apertures should be suitably situated so that fresh material can be added from above.
5. The raking apertures must give sufficient room for efficient raking and for cleaning out the whole interior.
6. A long chimney is necessary for a closed incinerator to ensure a good draught.
7. Incinerators intended for the destruction of excreta should be fitted with a baffle arch.
8. Water tanks should be built into the incinerator whenever possible so as to utilize the heat for the provision of hot water.

A. Open incinerators

Open circular turf

Round a circle, 3½ feet in diameter, a wall, 1 foot high, is built of turf sods cut 9 inches wide and 1 foot in length. Four air inlets are cut at opposite points and covered with short bars, or other strong supports, to take the weight of the fire bars and the superimposed layers of turf; these air inlets should be funnel-shaped with the outer wider end 1 foot wide. Iron fire bars, at a distance of 2 inches from each other, are placed across and resting on the wall, which is then built up to a total height of 4 feet 6 inches.

Similar improvised incinerators can be made of bricks or other available material.

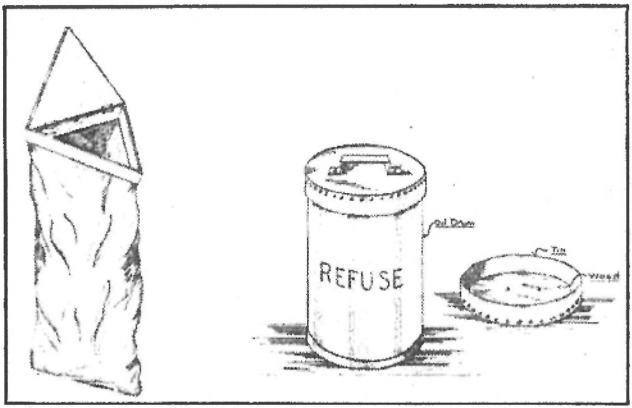

FIG. 37.—Fly-proof rubbish sack. Fly-proof bin and cover.

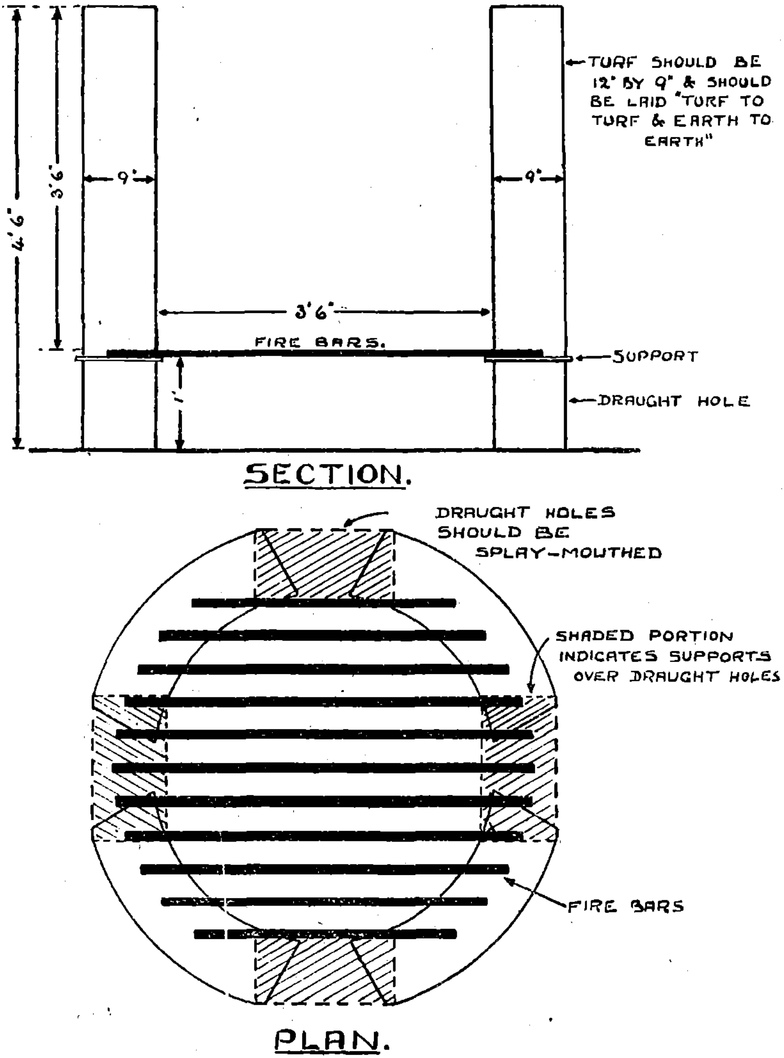

FIG. 38.—Open circular turf incinerator.

Open corrugated iron incinerator

This is made of materials which are always available in the field. It is easily put together and taken to pieces for transport. This type of incinerator is shown in Fig. 39, which is self-explanatory.

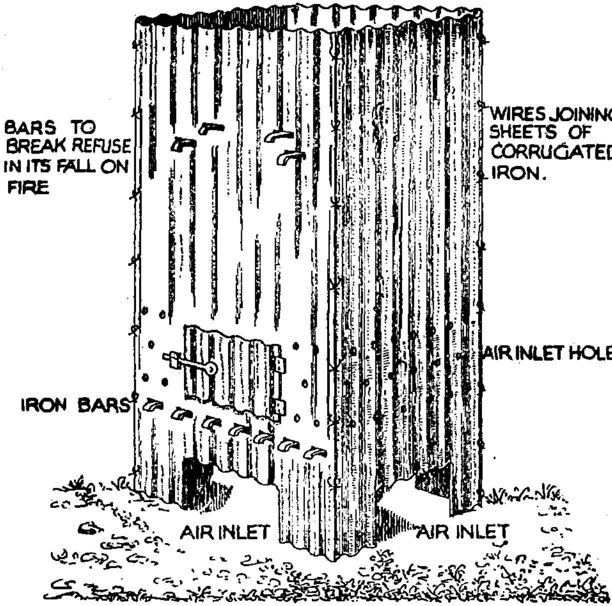

FIG. 39.—Open corrugated iron incinerator. 4 ft. 6 ins. high.

Basket and cradle incinerators have been described already.

B. Semi-closed corrugated iron incinerators

Corrugated iron

This is a portable type of incinerator, easily made and very efficient in wet or dry weather. It will burn wet as well as dry refuse and can be adapted to burn fæces.

It is made of four sheets of corrugated iron, fastened by means of wire (hay bale wire) secured through holes punched along the edges. Air inlets, 9 inches square, are cut out of the lower end of each sheet and above them are placed iron firebars supported through holes cut in opposite sides. Above the firebars various devices may be introduced for drying off

the material to be burnt and for feeding the fire slowly; these include graduated feed shelves, open bars across the body of the incinerator, flat drying shelves and raking doors.

An oil and water flash fire and drying shelf may be used with

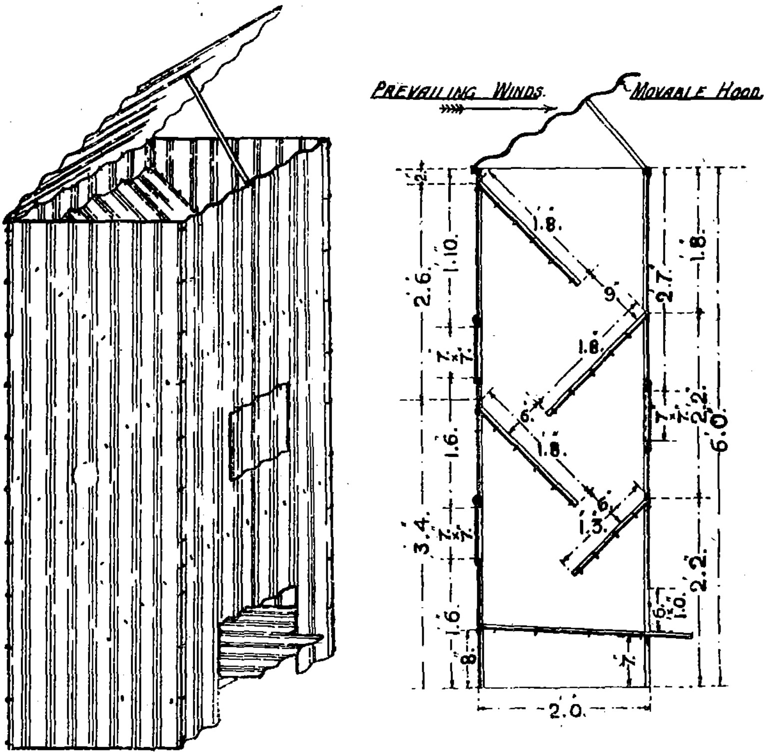

FIG. 40.—Semi-closed corrugated iron incinerator with graduated feed; can be adapted for flash fire.

this incinerator, but care must then be taken to regulate the flame properly or the material will be coated with soot and combustion will not be complete.

C. Closed incinerators

These are intended for burning excreta as well as wet and dry refuse.

Closed beehive

This is a circular incinerator and can be built of bricks or mud. There is a central chimney, a semi-top feed through a close-fitting lid, a raking door on the opposite side, fire bars placed loosely on a ledge and four air inlets. The height of the wall should be greater than its diameter.

The consumption of fumes and smoke may be secured by extending the chimney downwards inside the incinerator and supporting its lower end on two stout iron bars placed across the chamber above the level of the feeding door.

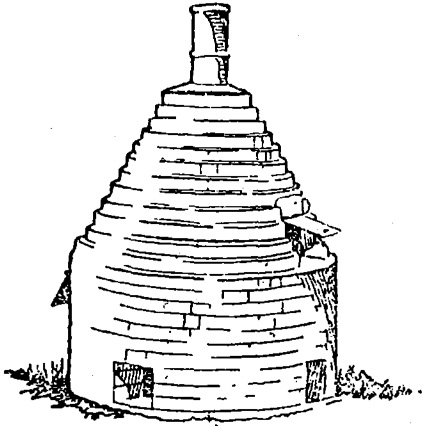

FIG. 41.—Closed beehive incinerator.

Bailleul incinerator

The Bailleul incinerator is capable of burning excreta and any refuse and has proved its efficiency in the Great War and since. It is a square incinerator and can be built of brick, or tins filled with earth, and metal sheeting, but the fire chamber should be lined with fire bricks for prolonged use. The feeding is through a door on the top and the consumption of fumes and smoke is ensured by an arched baffle wall.

A permanent hot water supply may be arranged by the inclusion of a water tank, as shown in Fig. 42.

Horsfall destructor

This is a trade pattern destructor built of steel plates lined with firebrick, the conservation of heat being further aided by a layer of slag wool between the metal casing and the fire-

brick lining. A baffle arch is provided for the combustion of offensive fumes, while a mushroom-shaped pedestal resting on the base provides for an effective draught, which is still further ensured by a high chimney of steel plate. The destructor must be placed on a broad concrete base. Instructions for working it are given in Appendix 13.

Brick built.

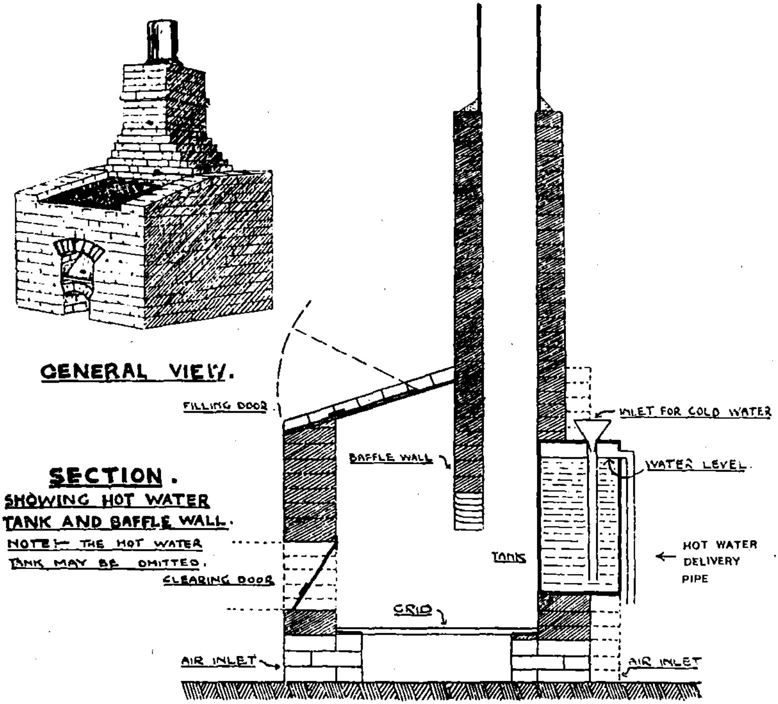

FIG. 42.—Bailleul incinerator.

Underground destructor

A chamber is excavated in the side of a hill, or suitable bank, with steps or an inclined roadway leading to the level of the bottom. The chamber is lined with firebrick and the top arched over with the same material. Fire bars of heavy metal, such as railway lines, are placed about a foot above the level of the bottom of the chamber and a raking door is constructed in the front wall.

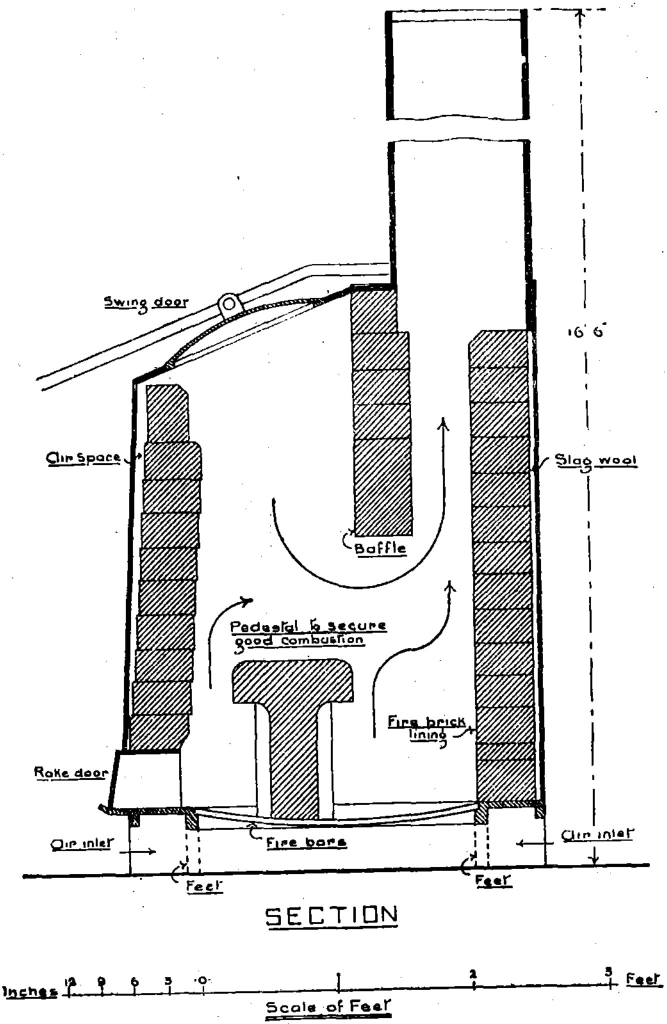

FIG. 43.—The Horsfall destructor.

Stoking is carried out through a feeding door on the top, reached by a roadway and platform, from which refuse may be tipped into the chamber; an inclined drying grid should be provided under this opening so that the refuse may be fed gradually on to the fire bars below.

The chimney should be high and built of brick or metal, but the lower part should be lined with firebrick and carried down into the chamber for fume consumption.

The cost of construction of these destructors is comparatively high, but they are very efficient, an intense heat being

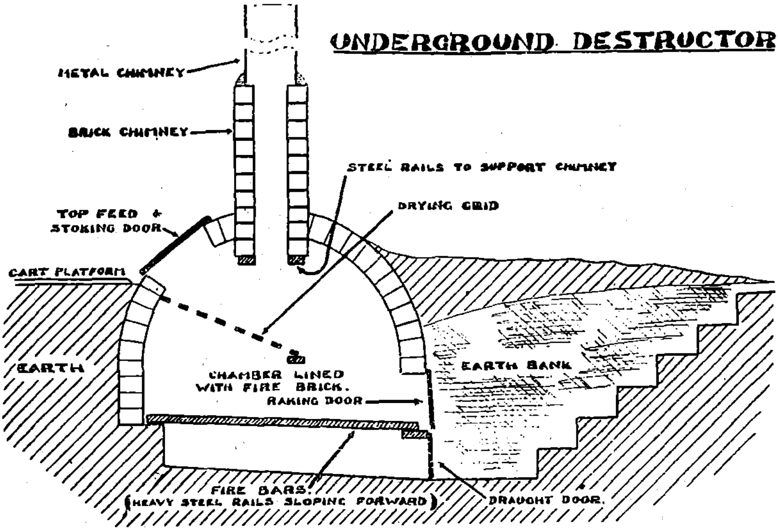

FIG. 44.—Underground destructor

produced in them. Large quantities of all kinds of refuse and even the carcasses of animals can be disposed of rapidly and completely in such an apparatus.

Disposal of carcasses and slaughter-house offal

The disposal of such material is best carried out in closed incinerators or destructors, otherwise it should be buried. When digging is necessary fatigue parties will be required, as in good soil one man can only excavate 30 cubic feet in the first hour and a total of 60 cubic feet (5×4×3 feet) in four hours' steady digging.

Field slaughter-house

A slaughter-house, or any place used as such, should be secluded but under close supervision. The floor should be cement or hard oiled ground sloping towards a central drain which should have some form of trap or strainer to catch solids, liquids being collected in a metal receptacle and buried in specially prepared pits. The receptacle for liquids should be kept above ground level and so placed that removal is easy; it should never be placed in a sump pit.

Offal, hides and bones, if not removed by a contractor, should be burnt in a closed incinerator or buried. When they are burnt, a supply of fuel is essential; when they are buried, a series of pits should be used and the offal covered with at least 3 feet of earth treated with heavy oil and well rammed down.

Carcasses

The problem of how to dispose of dead animals may assume serious proportions on active service. Burial is slow and laborious, a pit 10 feet deep being required for a dead horse, so that, when many carcasses have to be disposed of, it is unlikely that the burial of all of them will be possible, although the presence of large shell holes may solve the problem. The belly and intestines of a dead animal should be opened before the carcass is covered so as to allow of the escape of gases caused by putrefaction.

Burning is equally difficult except in a special destructor; the carcass of a mule, for instance, requires 80 pounds of hay or straw, 80 pounds of wood and 2 gallons of kerosene oil for complete destruction.

The usual course is to adopt a combined method of burial and burning. This consists of removing the carcass to a distance from a camp, cutting open the belly and chest and removing the intestines and internal organs, which are then buried in a pit nearby. The body cavity is then filled with hay or straw and set on fire; this will not consume the carcass, but it will assist in drying it up and lessening the evils consequent on its gradual subsequent decay. 40 pounds of hay or straw and 1 gallon of kerosene oil are required for dealing with the carcass of one mule by this method.

The carcasses of animals dying from communicable disease should be burned whole or buried in a pit containing quicklime.

CHAPTER IX

HYGIENE OF THE MARCH

Marching is a normal operation of dismounted troops and on it to a great extent depends their power and effectiveness, notwithstanding the facilities for conveyance afforded by modern mechanical transport.

To enable men to arrive at their destination at the end of a march in fighting condition, it is necessary that every officer and soldier should observe the principles of the hygiene of the march and the rules for march discipline which are based on these principles, failure to observe which might result in crippling the force or unit to which he belongs. Avoidance of such mistakes can only be ensured by training and education in the principles involved.

1. Preparation for Marching

Preliminary training

Training is as essential for marching as it is for athletics, boxing or any other skilled exercise; hence the necessity for constant attention to the care of feet, socks and boots, to personal hygiene, water discipline and march sanitation, and for regular and progressive training in marching which is emphasized in the various training manuals.

Feet

Training in marching should include the care and maintenance of the feet in good condition. Men should be taught how to take care of their feet and unit officers should learn how to conduct feet inspections. The regimental chiropodist, who receives special pay under the Pay Warrant, 1931, Art. 830, should if possible be present during all feet inspections by medical or regimental officers, and should subsequently carry out any necessary skilled treatment; this is especially important in the case of recruits. Sore feet may increase the energy expended on marching by as much as twenty per cent. and the rise of body temperature normally caused by marching may be increased by 1° F. from the same cause.

Instructions for the care of the feet are given in the Army Manual of Chiropody.

Boots

Inspections should be carried out by unit officers to ensure that each man uses army boots which are of good fit, pliable, well kept and in good repair. New boots should be fitted over army socks and with the full marching order load on the man's back. Further details are given in the Army Manual of Chiropody.

Clothing

The materials, fit and colour of clothing have been dealt with already in Chapter II, and it is only necessary to refer here to certain points regarding socks. Each man should have two pairs of socks which are sound and well-fitting; badly fitting, badly darned socks or those with holes are the commonest cause of sore feet. Soaping the socks, or the use of foot powder, will often prevent sore feet in men whose feet are abnormally tender.

Puttees should not be adjusted too tightly, because the legs swell as the march proceeds and the puttees will require readjustment; on the other hand, if adjusted too loosely, the puttees will come undone.

Equipment

The soldier's equipment should ensure an even distribution of the weight to be carried and the retention of the load in the best position for carriage.

Each individual soldier must have his equipment fitted when carrying his full load and inspections should be carried out by unit officers to ensure correct fitting. Only the authorized kit must be carried; there should be no pressure on bony parts nor interference with the movements of the chest, abdomen and limbs. The pack should be worn high up on the muscular part of the shoulders, and the load should be carried symmetrically.

Load

For infantry, the load which can be carried most economically with regard to energy expenditure is equal to about 30 per cent. of the body weight, *i.e.* approximately 42 pounds for a man weighing 140 pounds, and the effective maximum is equal to about 45 per cent., or 63 pounds for the same man. With loads of over 45 per cent. of the body weight, the amount of energy expended increases by three times as much as the load. The more energy expended on carrying excessive loads, the less there will remain to be expended on the distance marched and in fighting.

The loads carried by British infantry have varied considerably at different periods. During the South African War it was 59 pounds; in 1908 it was reduced to 52½ pounds, but during the Great War it was increased to 75 pounds in summer and 80¼ pounds in winter. It has now been reduced to 55 pounds 6¾ ounces.

In considering the load of the soldier it is interesting and instructive to compare it with the loads carried by various animals employed for transport purposes; those shown below are approximate only:—

Weights carried by transport animals and men on military service.

	Body weight	Load carried	Percentage of load to body weight
Elephant ..	7,840 lb.	1,100 lb.	14
Camel	1,120 lb.	300 lb.	22
Cavalry horse ..	1,100–1,150 lb.	Rider 150 lb. Equipment 115 lb.	24
Mule, pony or bullock ..	700 lb.	170 lb.	24
Trained soldier	140 lb.	$55\frac{7}{16}$ lb.	39·6
Recruit ..	135 lb.	$55\frac{7}{16}$ lb.	41
Coolie porter (does not fight) ..	140 lb.	50 lb.	35

2. Before the march

Medical examination should be carried out before a long march to weed out unfit men, who otherwise will invariably increase the demand for transport. Feet require careful attention; corns, blisters, ingrowing toenails and tender or sweating feet should receive attention from the regimental chiropodist or medical officer.

Night marches cause greater expenditure of energy than day marches. Too early a start means loss of rest, but too late a start will mean marching in the heat of the day or a long midday halt. Men should be roused in sufficient time to wash, have breakfast and visit the latrine, but should not be paraded and kept waiting for long periods before marching off.

The saying that " an army marches on its stomach " means that food supplies the necessary energy for marching and that the well-being of an army depends on satisfactory supplies of food. A light meal of bread, butter and sweet tea should be taken before the march; a heavier meal means an earlier réveillé or a start immediately afterwards, with the discomfort

of marching with a full stomach. At the midday halt a haversack ration should be eaten, and travelling cookers or hot boxes should be so used that a good hot meal is ready for issue as soon as possible after arrival in camp.

Water carts and bottles should be cleansed with double strength solution of water sterilizing powder beforehand and the carts and bottles filled with sterilized water overnight; hot weak tea may be used in the water bottles.

3. During the march

Marching may be defined as walking under conditions not controlled by the inclinations of the individual. It is a communal act performed by a body of men wearing uniform clothing, carrying a regulated load in a regulated manner and marching in step of a regulated length and speed. Walking itself is a complex muscular movement, which from long habit becomes practically automatic (for example, in sleep walking), and military walking, or marching, adapts this to military needs.

Pace and speed

The pace of a man is made by the leg swinging freely like a pendulum, the arc of the swing being six-sevenths of the total swing, giving an average length of step, or pace, of 27 inches. The regulation military step is a compromise between the ordinary walking pace of the average man and that of military necessity.

The regulation military pace and speed are :—

	Length of pace	Paces a minute	Yards a minute
Quick time ..	30 inches	120	100
Stepping out ..	33 ,,	120	110
Double time ..	40 ,,	180	200

The work done in moving the body forward is least at a speed of 82 yards (75 metres) a minute or 2¾ miles an hour.

With training, the pace of 30 inches becomes practically automatic, and alteration of the pace adds to the fatigue by causing a mental effort, hence the necessity for maintaining a regular pace and for awaiting the next halt to regain lost distance, instead of stepping out or doubling.

Heat production and its control

The energy required for the work of marching is supplied by the food taken. Only about one-third of the energy

supplied by food, however, is converted into energy for work, the remaining two-thirds being converted into heat, as explained in Chapter II.

In temperate climates, the energy used in marching is approximately 100 Kalories a mile, while the heat produced on a 15-mile march, even by a trained soldier, is about 900 Kalories more than when he is resting; the heat produced by an untrained man is much greater.

The following table gives the results of actual experiments on the expenditure of energy and heat produced by a man marching compared with a man at rest:—

	Men at rest	Men marching
Total expenditure in five hours ..	350 Kalories	1,736 Kalories
Expenditure on work during this period	117 ,,	579 ,,
Heat produced and requiring to be dissipated	233 ,,	1,157 ,,

The human body has a normal temperature of 98·4° F. when at rest, but its working efficiency is greater when its temperature is 100·5° F.; body temperatures of over 102° F. are abnormal and may be dangerous.

Heat is got rid of by radiation, conduction and convection, but chiefly by evaporation from the skin. On a 15-mile march about 1,200 Kalories of heat have to be dissipated, and anything, however trivial it may appear, which will assist this heat removal will make for efficiency in marching, although exposure of the skin and ventilation have the greatest effect.

Exposure of the skin surfaces can be attained by opening the neck of the coat and shirt, rolling up the shirt sleeves and wearing shorts, while the Indian practice of wearing the shirt outside the trousers is a valuable aid to the dissipation of heat from the body.

Ventilation of the ranks is necessary to prevent men in the rear breathing air which is full of dust and which is heated and moistened by the breathing and evaporation of sweat from the bodies of the men in front. Experiments have shown that the rear files of a company expended 6 per cent. more energy in marching than the front files.

Ventilation is carried out by changing the files after each halt, opening up on either side of the road, when possible, and changing the position of units in the column daily, as laid down in the training manuals.

The most should be made of halts for rest and getting cool.

Water requirements and water discipline

On a 15-mile march in a temperate climate each man has to get rid of about 1,200 Kalories of heat from his body by evaporation of sweat from the skin; this entails a loss of 2 quarts of water from the body, which amount must be replaced or thirst will become excessive and the body will suffer from lack of water. The water requirements on a march are 2 pints a man for every 7½ miles; under the present organization 1 quart of water is provided in the men's water bottles and 1 quart a man in the regimental water carts, so that the normal requirements can be met as shown in the diagram in Fig. 45. The requirements for untrained troops and in hot climates will be greater.

With training, strict discipline and good *esprit de corps*, troops can march 15 miles, or even more, without replacement of water loss but, if real fighting efficiency is to be maintained, an adequate supply of drinking water must be provided.

Water discipline must be maintained strictly for two reasons, first, to prevent men obtaining water from unauthorized sources, and secondly, to prevent wastage of water and therefore lack of it when really required.

The thirst of imagination requires no quenching, but the thirst of necessity is due to actual loss which must be replenished. Thirst can be diminished during a march by keeping the mouth shut, avoiding smoking, sucking pebbles or chewing gum.

The use of the water bottle should be allowed only at halts and then only sufficient water should be consumed to replace the loss from sweat; the drinking of large quantities of water is harmful and does not give any greater relief from thirst. Drinking from unauthorized sources must be strictly forbidden.

Halts

During the ten minutes halt each hour all ranks should be taught to rest as completely as possible, equipment being removed (anti-gas respirator excepted) and the men made to lie down, whenever conditions permit.

During long halts equipment can be removed, haversack rations consumed and water bottles and water carts refilled. During these halts rest and food should be available for all personnel; "runners," signallers, medical and sanitary personnel, who are often required for duty during halts, should be given as much opportunity for rest as possible.

A final halt should be made before entering camp to allow men to relieve themselves; this will prevent fouling of the camp area before latrine and urinal accommodation is ready.

d. 1. "Loss of salt by perspiration may lead to heat exhaustion or cramps. These may be prevented by the addition to the water bottle of one half teaspoonful of common table salt (sodium chloride) at each filling thereof."

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Conservancy

Short trench latrines, trench urinals and a refuse pit should be provided at halts (*see* Chapter VIII). Elaborate arrangements are not practicable and are not required, but it must be remembered that a route may be used for weeks on end by

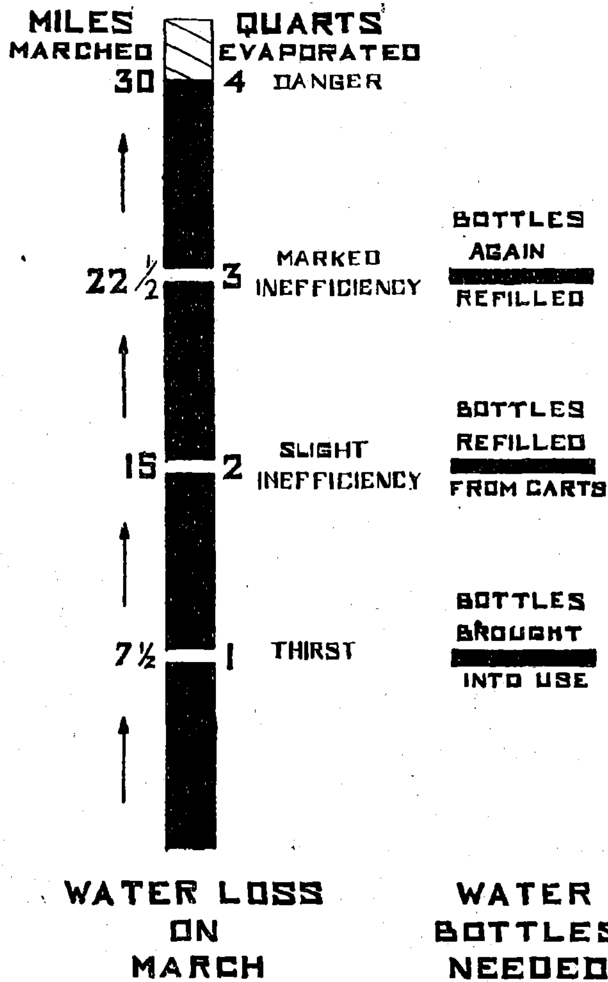


FIG. 45.—Water needs on the march.

a succession of units and good sanitation along the route is necessary to maintain efficiency and health. Care must be taken that all latrines, urinals and pits are filled in after use and the sites marked prominently.

Smoking

The psychological effect of smoking is very great and therefore, to those accustomed to it, great comfort is derived from it, especially at times of stress and hunger; it does, however, create a dry mouth and throat and thereby increases thirst.

At the Army School of Physical Training, Aldershot, it has been shown that smoking has a detrimental effect on endurance, makes the heart more irritable and sensitive, with a consequent earlier onset of fatigue, and lengthens the time taken for the pulse rate to return to normal after exertion. Experiments carried out over a period of ten years have shown also that, in distance running, heavy smokers (20 cigarettes or more a day) form two-thirds of the number finishing in the last ten, while non-smokers form two-thirds of those finishing in the first ten.

Smoking is such a universal habit that it would be difficult to stop it altogether, but it should be limited to the earlier stages of the march when the body has not lost much water and when the water bottles are not empty.

Mental stimulation

Monotony has a depressing effect and induces fatigue in marching as in any other form of work. Change of interest has a stimulating effect, for it makes a march appear easier and lessens the feelings of thirst and fatigue; the playing of a band, singing, whistling or alternation between marching at ease and at attention can all be employed to stimulate the mind.

Ambulance wagons should be kept in the rear and, if possible, out of sight, as their presence frequently causes an increase in the number of men falling out.

Position of medical officer, water duty and sanitary personnel

The medical officer should remain in rear of the column, where he will be in a position to watch the effect of the march on the men and attend to any who fall out. Before a long halt and before arrival in camp, he should go forward to advise on the selection of water supplies and the provision of sanitary arrangements.

Water duty personnel should march with their water carts and sanitary personnel in rear of their companies, except when required to go forward at halting places.

4. On Completion of the march

The lay-out of the camp is arranged as described in Chapter VII.

Latrine and urinal accommodation of some kind, if only of a temporary nature, must be made ready by the sanitary personnel with the advance party for use of the men of the unit on arrival; this temporary accommodation can be added to or improved when full sanitary arrangements are being made. On the arrival of the unit, the lay-out of the camp and the location of latrines, urinals and other camp sanitary arrangements should be explained to the men before they fall out.

Food

Hot, sweet tea is the best "muscle restorer" and should be served as soon after arrival in camp as possible. After the necessary fatigues and camp duties have been performed, the men should be given the main meal of the day, served hot from the travelling kitchens.

Alcohol may be issued, on the recommendation of a medical officer, after severe exertion under trying conditions, but it should only be given if shelter and rest are available and just before the men turn in, so as to produce a feeling of comfort and to induce a good night's sleep.

Foot inspection

The men's feet should be inspected by platoon officers after every march to ensure proper attention to feet, socks and boots. The following routine should be adopted:—

1. Remove the boots and dry them.
2. Remove the socks and wash the feet in cold water. If the feet are tender, they should be rubbed with spirit or alum solution and then dusted with foot powder consisting of salicylic acid 3 parts, zinc oxide 10 parts and powdered talc 87 parts. All blisters and sores should be treated by the regimental chiropodist or medical officer.
3. Put on clean dry socks and shoes.
4. Wash out and dry the socks taken off, stretch and rub them soft and darn any holes.

If this procedure cannot be carried out in full, a change of socks or shaking and changing on to opposite feet to those on which they have been worn, airing the feet and rubbing them vigorously with a dry towel will give relief and help to keep the feet healthy.

Cleanliness

During a march the body and the clothing become soaked with sweat and special attention to cleanliness is therefore necessary. Men should be given every opportunity for bathing and for washing their underclothing. When it is not possible to obtain a bath, the body should be rubbed down with a towel.

CHAPTER X

ANIMAL CARRIERS OF DISEASE

Many animals, especially insects, play an important part in the spread of disease among mankind, because they constitute a route in the cycle of infection, as explained in Chapter III.

They may either act as direct carriers by conveying the disease germs in or on their bodies, as in the case of the house fly, or they may be indirect carriers by acting as hosts to parasites, the parasites undergoing part of their cycle of development in the host before they become infective to man, as in the case of malaria parasites in the mosquito.

Such animals are called disease vectors and methods for the prevention of diseases carried by them must therefore include measures against the vectors. For this purpose it is necessary in each case to have a knowledge of the life history of the vector and how it conveys infection; it is then possible to devise methods of prevention, which should include :—

1. the destruction of the vector as early in its life as possible;
2. the abolition of breeding places;
3. the prevention of access of the vector to any source of infection;
4. the protection of man, and his food and water supplies where applicable, from infected vectors.

In practice, no one method is as a rule completely successful and a combination of methods must be used; success will depend on attack at all points and over as wide a range as possible. The task of exterminating all flies or mosquitoes, for example, would be too great and efforts must perforce be limited to the immediate neighbourhood of military personnel, although much can be done by co-ordinated efforts and collaboration with the neighbouring civilian community.

Flies

The house fly (*Musca domestica*).—The importance of the house fly as a disease vector is due to the fact that it is closely associated with the spread of the excremental diseases, typhoid fever, paratyphoid fever, cholera, dysentery and diarrhœa. The germs of these diseases are passed in human excreta,

which have an irresistible attraction for house flies. The flies feed on the excreta and in so doing swallow the germs, and at the same time their feet become contaminated. Human food, especially those articles usually eaten uncooked, such as milk, sugar, jam, bread and cheese, are almost as attractive to flies as human fæces and the flies may feed alternately on fæces and food. Germs are carried by a fly on its feet and in its crop; some germs also pass unaltered through a fly's intestine within certain time limits. When the fly feeds, it drops its fæces frequently, it regurgitates food from its crop, and also walks over the food which is thus contaminated in three ways.

In addition to the diseases mentioned above, house flies may act as vectors in certain infective eye conditions and may possibly also assist in spreading tuberculosis, leprosy and small-pox.

Life history.—Breeding only takes place in material that will provide food and a home for the maggots, such as fermenting horse manure, human fæces and decaying refuse. Horse manure is attractive to flies only so long as it is fresh, and breeding does not take place in old heaps or those that are tight-packed. Peat litter does not breed flies.

The eggs are glistening white and like minute grains of polished rice; they are laid in masses in cracks and in the shade. Female flies like company when depositing their eggs and may be seen clustered in groups; each female lays 120 to 150 eggs at a time and may deposit 5 to 20 batches during her lifetime, thus producing from 600 to 3,000 eggs.

In 8 to 24 hours the eggs hatch into dirty white segmented maggots, which remain under cover, feed and grow rapidly; if disturbed, they burrow rapidly but at night they come out on the surface. Provided the heat is not too great to dry up the food material, development is accelerated by high temperature, and in hot weather the maggots are fully developed in 3 to 5 days; development is delayed by cold and wet and may take 6 to 8 weeks. The fully fed maggot, ready to pass to the next stage, has an ivory yellow waxy appearance. It ceases to feed and makes its way to the outside of the base of the manure heap where it is drier and not so hot; small heaps of these mature maggots may usually be found under the straw at the edge of the heap. They may burrow into the earth to a depth of 2 feet and within a radius of 4 feet from a manure heap. From trench latrines they burrow into the ground outwards and upwards.

The pupal or chrysalis stage succeeding the maggot is a resting stage and lasts from 2 days to 4 weeks, according to temperature. The pupa, or grub, lies motionless and looks

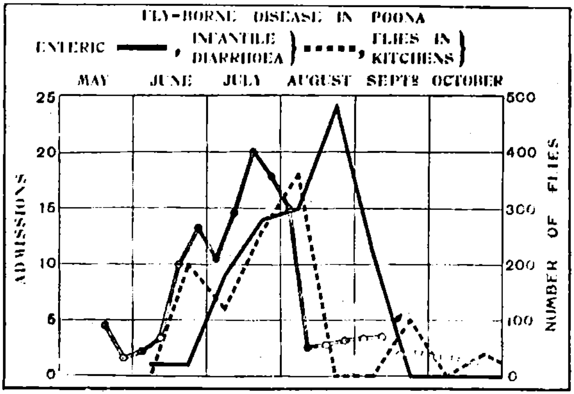
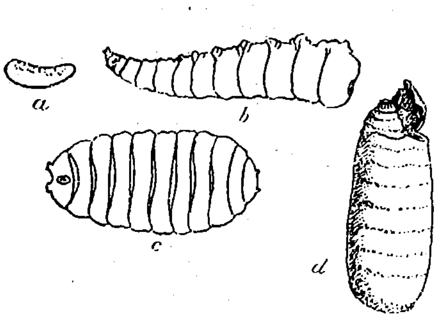


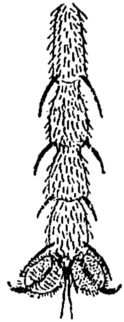
FIG. 46.—Relation of fly prevalence to typhoid fever.

like a minute sausage, which is at first yellow in colour but turns brown and finally black before hatching.

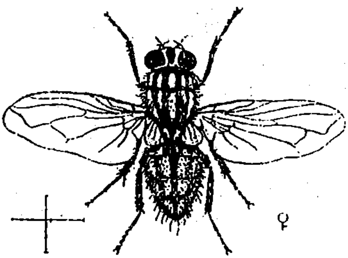
The adult fly hatches out from the grub and burrows its way up to the surface of the earth. When newly hatched, it is lacking in colour, has a shrunken appearance and its wings are shrivelled and incapable of flight, but within an hour the



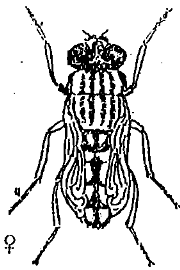
a. Egg. *b*. Larva. *c*. Pupa.
d. Empty puparium.



Foot, showing hairs on which bacteria, etc., lodge.



The common house fly (adult).



Just emerged from the pupal case. Note the wings, as yet unexpanded, folded and crumpled on the back of the insect.

FIG. 47.—The common house fly (*Musca domestica*).
N.B. + indicates actual size.

body and legs harden and the wings dry and spread out ready for flight.

The total life cycle takes from 13 to 25 days, but depends greatly on temperature, development being hastened by heat, and retarded by cold wet weather; in hot countries the development from egg to adult takes about one week.

The importance of fly control is best understood when it is realized what enormous numbers of flies may result from uninterrupted breeding. One batch of 150 eggs may result in seven weeks in 800,000 flies; a female fly, however, may deposit many such batches in her lifetime and therefore may be the ancestress of as many as five million other flies.

The average life of a fly, in hot weather at the height of the breeding season, when its activities are greatest, is about 8 to 10 weeks, but in late autumn and early winter in warm situations indoors it may live much longer.

There is no support for the theory that house flies hibernate. Where then do they go in winter? The majority die, but some survive in places where there is warmth and access to food, as in kitchens and restaurants, and slow breeding probably takes place in favourable situations such as stables. The occurrence of swarms of flies may be attributed to (*a*) weather conditions favouring rapid development, and (*b*) the existence of breeding places with ample food supplies for maggots resulting from the constant use of manure heaps and the exposure of excreta and refuse—in other words, bad sanitation.

House flies are most active in daylight and avoid dark places; after dark they settle down and do not fly unless disturbed.

Fly control.—The prevention of breeding is more effective and easier than the destruction of adult flies, but all preventive measures should include the destruction of eggs, maggots and grubs and the destruction of adult flies.

1. Destruction of eggs, maggots and grubs.

   Manure, human fæces and refuse form the chief breeding places and should be dealt with as described in Chapter VIII.

2. Destruction of adult flies.

   Swatting.—Large numbers of flies can be destroyed by systematic swatting, especially before mealtimes. The best form of swatter is made of fine-mesh flexible wire gauze bound at the edges with tape.

   Tanglefoot.—This can be made by heating resin just sufficiently to melt it and then mixing castor oil with it in the proportion of 5 parts by weight of castor oil to 8 parts of resin. The mixture can then be spread on glazed paper, wires and tins. Wires are the best, as they form an ideal resting place for flies; a cork should be secured to the lower end of the wire to prevent the tanglefoot from dripping off the wire (*see* Appendix 14).

When covered with flies or when the tanglefoot becomes dry, fly papers should be burnt, but wires and tins can be placed in a fire to clean them and again coated with fresh tanglefoot.

Traps.—The efficiency of fly traps depends on their construction and how they are baited. There should be a landing platform, easy access to the bait and a narrow entrance into the chamber of the trap, which should be lighted from above to attract the flies after feeding. Traps should be baited with sugar, jam or treacle mixed with beer, chicken entrails, fish or other suitable bait.

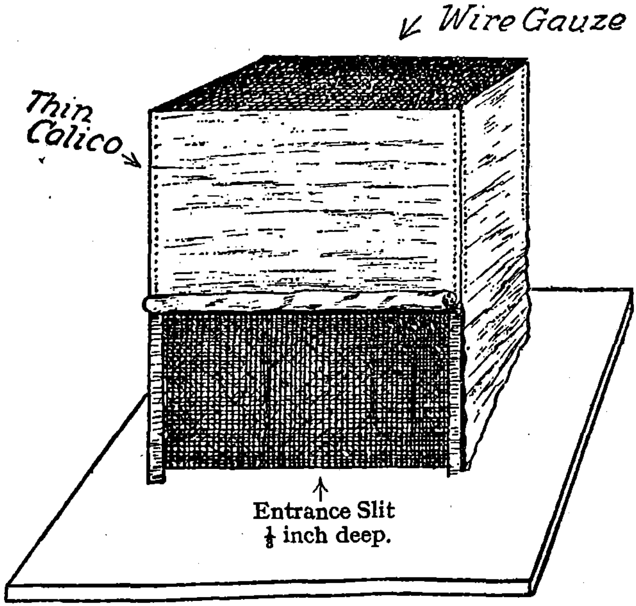


FIG. 48.—Box fly trap.

The balloon trap is one of the most efficient, while the cage trap, placed near latrines and kitchens, may catch large numbers of flies.

Poisons.—Formalin and sodium arsenite solution are the two most commonly used (*see* Appendix 14). Formalin is used in dining-rooms and kitchens in simple traps made from glass jars with a wick; it is most effective in the early morning, but care must be taken that no other foodstuffs or water are accessible to the flies.

Sodium arsenite is used in roller-towel fly traps. These should be placed out of doors near latrines and manure heaps, in the shade in sunny weather and in the open in dull cloudy weather. The trap consists of an endless piece of sacking kept moist by being drawn through a metal trough containing the arsenite solution.

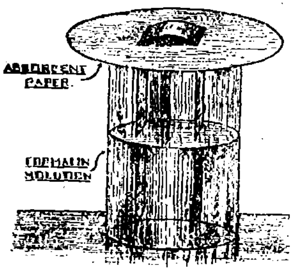


FIG. 49.—Formalin fly trap.

Spraying.—This is useful indoors for domestic purposes but is of little use in the field, except that sodium arsenite solution may be used for spraying manure heaps.

There are many fly spray solutions on the market but one of the most effective is a solution consisting of

soap, $\frac{1}{4}$ pound ;
water $\frac{1}{2}$ gallon ;
kerosene oil, 1 gallon.

Flaming.—Large numbers of flies may be killed by applying a naked flame to wire and other places where flies settle at night, precautions being taken, of course, against setting fire to any inflammable material.

General precautions.—Larders should be fly-proofed ; milk jugs, jam dishes and similar utensils should be covered with gauze, and glasses, cups and plates turned upside down when not in use.

A fishing net with a $\frac{3}{4}$-inch mesh, suspended loosely over doors and windows, will keep flies out of a room.

In hospital wards, precautions must be taken to prevent flies settling on sores or infectious patients, and to prevent the access of flies to sputum and excreta.

Flies resembling house flies

The lesser house fly (*Fannia*) is the common latrine fly and is smaller and more slender than the house fly. It breeds in human fæces and old vegetable refuse and forms the vast majority of flies found in houses in the early summer. It is the fly usually seen weaving aerial patterns round lamps.

The stable fly (*Stomoxys calcitrans*) is a biting fly which breeds in stable litter and cut grass. It can be recognized by its biting proboscis.

The cluster fly (*Pollenia rudis*) is larger than the house fly and rests with its wings folded back. Its name arises from the fact that it hibernates in clusters.

The *Musca autumnalis* is more bulky and thickset than the house fly and it breeds in cattle droppings in fields.

Other flies of importance

The tse-tse fly (*Glossina*) transmits sleeping sickness and is only found in Africa and Arabia.

Carcass flies :—flesh flies (*Sarcophaga*) ; blue and green bottles (*Calliphora*, *Lucilia* and *Chrysomyia*, the common Indian bazaar

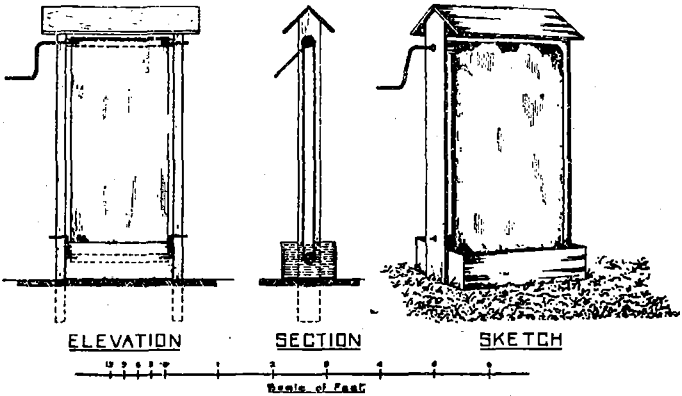


FIG. 50.—Roller-towel pattern fly trap.

fly). These flies live on flesh and their maggots may be found in sores and wounds; maggot-infested wounds do not produce gas gangrene.

Bot or warble flies (*Œstridæ*) are hairy and bee-like and are chiefly of veterinary importance, although some may infect human beings.

Mosquitoes

The two most important tribes of mosquitoes are the anophelines and the culicines. Many species of anophelines spread malaria and some of the culicines spread dengue fever, yellow fever and elephantiasis, but in all cases the female only is the vector of disease. Female mosquitoes feed on human

blood and on that of animals; they suck the blood after biting through the skin. If the blood is from a human being and contains malarial parasites, these parasites undergo a cycle of development in the body of the mosquito and after a certain period the mosquito is able to transfer them to other human beings whom it may bite. (*See* Malaria in Chapter XII.)

A mosquito is a two-winged, six-legged insect having a head, thorax and abdomen. The head is furnished with two antennæ by which the sex can be distinguished, the antennæ of the male being heavily plumed, while those of the female have only sparse hairs. It is important to be able to distinguish the sex.

Between the antennæ project the long proboscis and two palpi. The palpi of the female anophelines are as long, or nearly as long, as the proboscis, while those of the female culicines are distinctly shorter and may even be quite short and stumpy; the palpi of the male anophelines are clubbed at the end.

The resting attitude of the insect is of value as a distinction, for the culicine is hump-backed and rests parallel to the surface, while most, but not all, anophelines have no hump and appear to stand on their heads.

Life history.—After a feed of blood the female makes for a quiet place where she can remain until her eggs mature, and in a few days she makes for water, on the surface of which she lays her eggs.

The eggs are cigar-shaped and those of the anophelines are provided with side floats and are laid singly or in star-shaped clusters; culicine eggs have no floats and are laid in clusters forming small rafts with a concave upper surface. Usually after a few days the eggs hatch out into larvæ which swim about actively and are about half an inch long when fully grown. Anopheline larvæ progress in a series of darting movements, while culicine larvæ wriggle along.

The larvæ feed on minute animal and vegetable particles in the water, anophelines being surface feeders, culicines feeding at any depth. They come to the surface of the water to breathe air, and culicine larvæ are provided at their tail end with a prominent syphon or breathing tube, through which they breathe and by means of which they hang suspended head downwards. Anopheline larvæ have no syphon but lie parallel to the surface of the water and breathe through two small papillæ at their tail end.

The larval stage lasts from a few days to several months according to conditions of temperature; when conditions are suitable, the larva casts its skin and becomes a pupa.

The pupa is comma-shaped and consists of a large head with a tail attached. It does not feed but breathes air from the

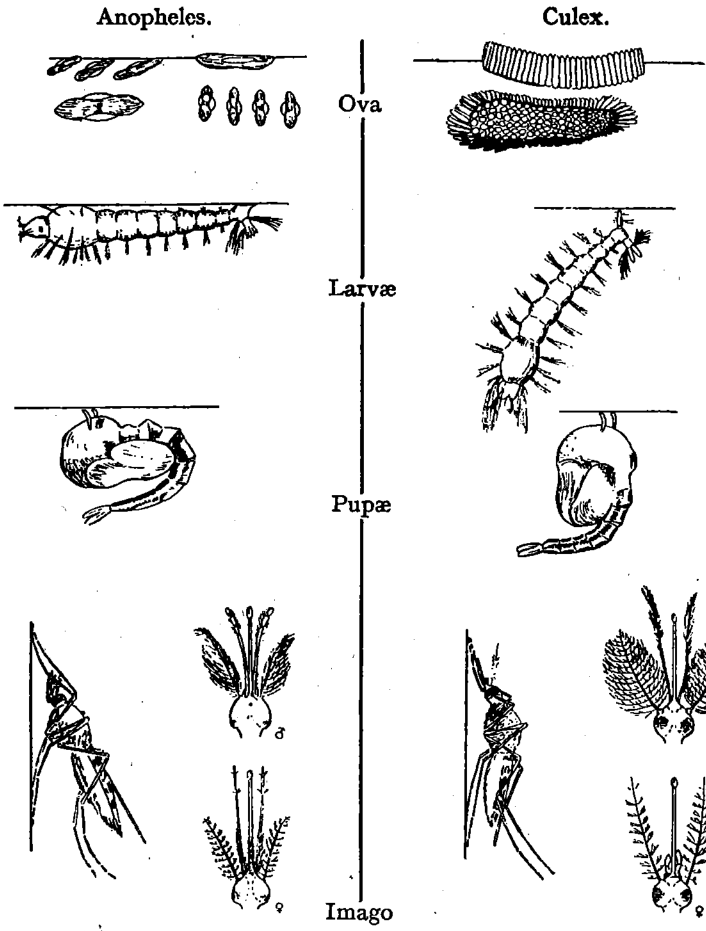


FIG. 51.—Life Cycle of Mosquitoes; Anopheline and Culicine.

surface through two small trumpets or tubes. There is little difference between anopheline and culicine pupæ.

In one to five days the pupa comes to rest on the surface of the water, its skin splits and the imago or adult mosquito emerges.

Adult mosquitoes can travel considerable distances, even up to a mile or further if the wind is favourable and there are suitable resting places en route, although normally they do not fly much more than 600 yards, for they prefer to remain near food supplies and breeding places.

Mosquitoes usually shelter in shady places by day and come out to feed at night, although many species feed by day. Anopheline mosquitoes tend to leave houses during the day and seek the shelter of bushes and jungle outside; often, however, they may be found hiding in dark corners, cupboards, behind clothing or curtains, and in animal sheds.

Different species of mosquitoes prefer localities with different characteristics, and antimalarial measures cannot be effective unless the habits of the local mosquitoes are known. In order to carry out specialized preventive measures, it is necessary to be able to distinguish between anopheline and culicine mosquitoes and to identify different species, but for general practical purposes war should be waged against all mosquitoes for the reason that, although they may not all be transmitters of disease, they cause considerable irritation and loss of sleep by their bites.

Preventive measures

1. *Protection against mosquito bites.*—Individuals can protect themselves against the bites of mosquitoes either by means of some protective covering for exposed surfaces of the body, such as mosquito nets, mosquito boots, veils, gauntlets and turned-down shorts, or by the use of repellants (culicifuges) applied to the skin.

The use of mosquito nets forms the great stand-by in most countries for the prevention of malaria. The mesh of the nets issued to the Army is 28/29 holes to the square inch and the material of 30/40 cotton; a wider mesh allows mosquitoes to pass through the net. (*See* Appendix 14.) Nets must be used properly or they are worse than useless; they must be kept in good repair, hung inside the supporting poles and tucked in under the mattress all round the bed. The net should be let down before dark and stretched tight to allow air to pass through it, and the inside of the net should be searched, preferably with an electric torch, for any mosquitoes which may be inside. In the morning, the net should be turned

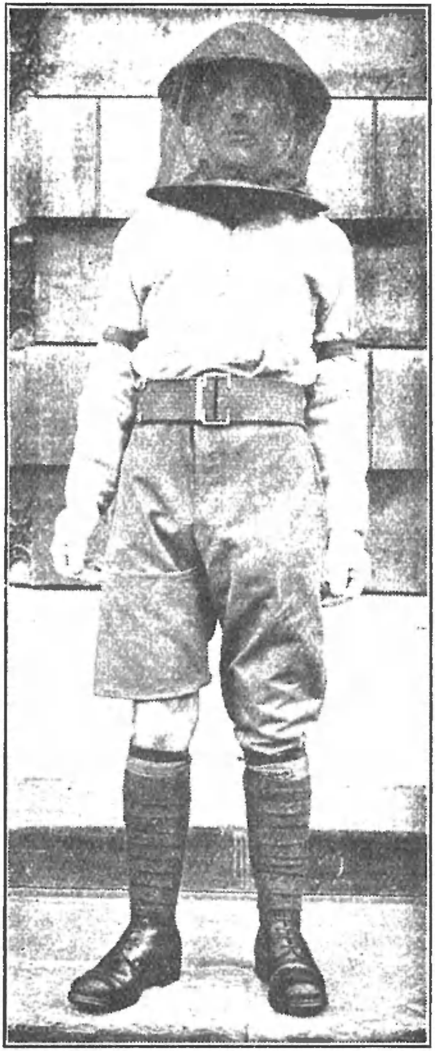


FIG. 52.—Protective clothing.

inside out, tightly rolled and tied with tape to prevent mosquitoes secreting themselves in it in the day time.

Culicifuges are useful for short periods when men have to be out at night, but they have the disadvantage that their effect wears off in about two hours or less. There are many preparations which can be used, and the most efficacious, although expensive, is oil of citronella. A very good preparation is that known as "P.C. Oil" (paraffin, citronella), which consists of :—

Oil of citronella	$1\frac{1}{2}$ parts
Liquid paraffin	1 ,,
Coconut oil	2 ,,
Carbolic acid	1 per cent.

Electric fans or punkahs keep away mosquitoes by creating a draught, but a hungry female mosquito may succeed in biting by getting into shelter to leeward; hand-propelled punkahs are unreliable, as their efficiency depends on human wakefulness and energy, and punkah coolies are frequently reservoirs of malarial infection. Hand fans may be used but are not sufficient by themselves.

Collective protection against mosquito bites is obtained by the mosquito proofing of barracks and houses. All outside doors, windows, chimneys and other openings, including drains, are screened with fine mesh copper wire gauze; screened doors must open outwards, be self-closing, and have a lobby inside with another screened door at the other end of it and at such a distance and so arranged that one door is shut before the other can be opened (Fig. 53).

The advantage of such mosquito proofing is that rooms are kept free of mosquitoes and nets are unnecessary; this adds greatly to comfort and coolness and thereby ensures better sleep.

"Cold storage" is an anti-malarial method used in India and consists in removing susceptible personnel to hill stations during the malarial season; special precautions must be taken that men are not infected while passing through the heavily infected areas in the foot hills and are not returned to the malarial stations before the end of the malaria season.

Protection against mosquito bites not only protects men from bites but prevents mosquitoes from becoming infected by biting people whose blood contains malaria parasites. It is not sufficient only to prevent mosquitoes biting, other preventive measures must be adopted as well.

2. *Destruction of adult mosquitoes.*—Swatting may be carried out with "fly-swatters" or by means of the hand covered

with a lather of soap, the latter being very effective (*see* Appendix 14). Spraying with 5 per cent. formalin, cresol solution, or other suitable preparation, of which there are many on the market, is useful for clothing, dark corners, cupboards and other similar places where mosquitoes lurk.

Fumigation may be used as an alternative to spraying if mosquitoes are very numerous, and the cheapest fumigant is cresol, of which about 5 ounces are required per 1,000 cubic feet. The room must be kept completely closed during fumigation and, when it is opened afterwards, all mosquitoes must be swept up and burnt before those which are merely suffocated

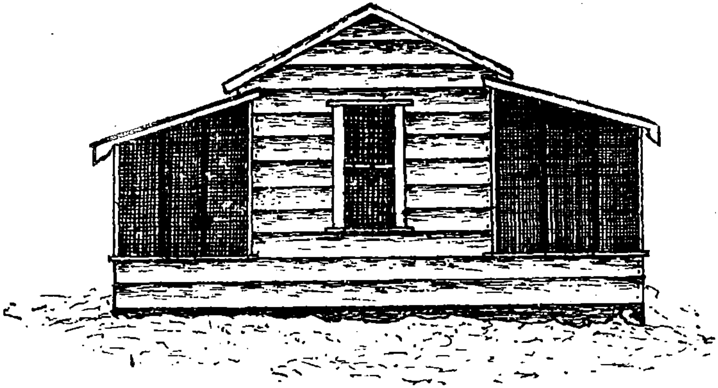


FIG. 53.—Mosquito-proof hut with verandah. Wire gauze of tinned iron, copper, or brass for windows, verandahs, etc. Double self-closing doors.

have time to recover. Fumigation is not very effective in barracks with high roofs.

Traps are of two types; one type is a cage trap placed in window openings, the other is a dark box placed in a cool shady place out of doors where mosquitoes rest by day.

The destruction of long grass and coarse herbage has the effect of removing cover for mosquitoes.

3. *Prevention of mosquito breeding.*—This is the most effective anti-mosquito measure, but it is one which requires considerable experience and training of the staff employed in carrying it out; it also involves the expenditure of money, but this expenditure is a good investment.

The principles to be adopted are as follows :—

A. The removal of possible breeding places by drainage.

B. The effective screening of collections of water, such as wells and cisterns, which cannot be removed.

C. The use of natural enemies, such as larvicidal fish and aquatic plants.

D. The use of (i) oil, which forms a film on the surface of the water and so prevents the larvæ breathing, or (ii) chemical substances, such as Paris Green, which, when spread on water and eaten by the larvæ, poison them.

Drainage of marshes is carried out by means of open, subsoil, herring-bone or contour drains. Subsoil drainage should always be used when practicable.

Streams should be canalized, weeds removed and the edges kept free of vegetation so as to give no cover for larvæ.

Should the malaria vector be *A. maculatus* or *A. minimus*, however, this procedure should not be adopted unless efficient oiling and other measures of prevention are carried out, as these species of mosquitoes breed freely in clear running streams and do not like shade.

Watering places for animals can be defined by fencing and should be paved to prevent hoof marks being left in the mud.

Water supplies, such as wells and cisterns, should have all openings screened ; small tanks and horse troughs should be emptied and dried thoroughly at least once a week. All small collections of water such as are found in household utensils, gutters, drains, holes in trees and empty tins may afford breeding places and must be attended to.

Fish of many varieties prey upon mosquito larvæ, but can only do so if they can reach the larvæ ; canalization of the banks of streams and connection of all minor pools with the main stream is therefore essential. The use of fish is attended with many difficulties, amongst the greatest of which are zealous fishermen in the form of small boys and ducks.

The most useful larvicidal plants are those which cover the whole surface of water so thickly as to prevent the larvæ breathing, such as duckweed, and those which entrap larvæ, such as bladder worts.

Larvicides.—A cheap and efficient larvicide consists of a mixture of one part of kerosene oil with two parts of crude heavy oil. It can be applied as a spray or by means of drip cans, floating cans or plugs of tow, or with a watering can, according to the nature of the water to be treated. Oil acts as a poison and by clogging the breathing tubes.

Paris Green is a green powder containing arsenite of copper, is practically insoluble in water, and is a most effective larvicide. It is mixed with road dust, sawdust or some other similar material to keep it afloat and is then sprayed over the surface of the water. The particles are eaten by anopheline larvæ, which are surface feeders, and the chemical acts as a poison. To be effective against culicine larvæ, which feed below the surface, Paris Green must be mixed with wet sand or some other material which will carry it below the surface of the water.

Paris Green is most useful for large areas of water which cannot be controlled effectively by oiling. The quantity required is about one pound of Paris Green to the acre and the dilution with dust should be about 5 per cent. for large areas of water and 1 per cent. for small (*see* Appx. 14).

It has no effect on domestic animals, fish, or crops such as rice, and the water treated is not rendered unfit for domestic purposes; its disadvantages are that it does not kill pupæ and, as it contains arsenic, care must be taken by persons handling it.

Sandflies (*Phlebotomi*)

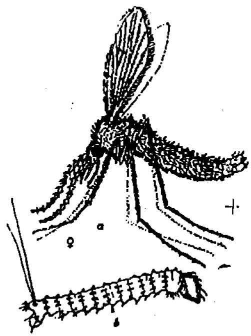
Sandflies carry sandfly fever, oriental sore and possibly kala azar; in most species it is only the females that suck blood and their bites are intensely irritating and cause loss of sleep. When a sandfly sucks the blood of a person in the early stages of sandfly fever, the germ takes seven days to develop in the body of the sandfly, which is then capable of infecting other persons and continues to be infective for several weeks.

The sandfly is a very small hairy winged insect difficult to see against a dark background. It feeds at night and shelters during the day in dark places; when disturbed, it moves in short rapid zigzags, but its flight is weak and limited to about 50 yards from its breeding places. It does not fly high and is blown away by a slight breeze, so that considerable protection can be had by persons sleeping on the roofs or upper storeys of buildings and by the use of fans. Owing to its small size, the sandfly can easily pass through a mosquito net, and special sandfly nets of 46 mesh to the square inch and 120/120 cotton are necessary.

The female lays her eggs, up to about 40, in cracks in damp dark cellars, caves, dugouts or damp crumbling walls. The eggs hatch in about a week into small caterpillar-like larvæ having two long bristles at the tail end. These larvæ require shelter and darkness and also damp decaying organic matter to feed on. When fully grown, the larva becomes a pupa, from which the adult sandfly hatches in about 14 days.

Preventive measures, as in the case of mosquitoes, consist of protection from bites, the destruction of the adult flies and the prevention of their breeding.

Protection from bites is obtained by sandfly nets, mentioned above, by sleeping as high up as possible and by the use of fans and culicifuges. Adults are destroyed by swatting, by spraying, or by the use of fly papers, which, if placed round lighted lamps at night, will catch a considerable number of sandflies as well as other insects.



a. Imago. *b*. Larva.

FIG. 54.—Sandfly (*Phlebotomus*).

N.B. + indicates actual size.

The prevention of breeding should include the following measures :—

1. Levelling, draining and rendering impermeable, or spraying with tar, all ground for a distance of 20 feet from the sleeping quarters.
2. Repairing cracks and holes in walls, embankments, drains, gullies and soakage pits.
3. Whitewashing or painting the interior of rooms and tarring the lower three feet of outside walls.
4. Attention to the cleanliness of ventilators, gulley traps and rooms, especially at the junction of walls and floors. The removal of cobwebs is important.
5. The proper disposal of all refuse, including collections of stones, mortar, sand, etc., from broken-down houses, walls and other such places.
6. The clearing of vegetation for 200 yards round inhabited buildings.

All necessary repairs, tarring, painting and whitewashing should be carried out just before the onset of the hot weather.

Lice

Lice have always been associated with wars and famine; they have been referred to in the works of ancient Greek authors and have even been the subject of a poem in more recent times. This notoriety is well deserved, for by their bites they spread typhus fever, also known as famine fever or jail fever, a deadly disease, which has scourged many countries and armies. Lice also spread relapsing fever and trench fever, while the irritation caused by their bites gives rise to scratching and consequent inflammatory conditions of the skin from the entry of germs into the bites and scratches.

Typhus fever is spread by the bites of infected lice or by their excreta being rubbed into scratches or sores.

Relapsing fever is spread by louse excreta or by infected lice being crushed or rubbed into the skin, although infection may come from bites also.

Trench fever is usually spread in the same way by fæces from infected lice, which is very infective. Healthy men without any cuts or scratches may even be infected by getting the fæcal dust in their eyes, as when blankets are shaken. The bites of infected lice apparently do not produce trench fever, although this has not been definitely proved yet.

Lice are small, flat, greyish-brown, wingless insects, which live among the hairs of the body and in clothing, especially underclothing. There are three kinds of lice:—head lice, body lice and crab lice. Crab lice may be distinguished by their smaller size, square body and lesser activity; they usually inhabit only the crutch and armpits and they are not known to transmit any disease.

Life history.—The female lays her eggs with care on body hairs or on fibres of clothing, where she shows special preference for seams and linings. The eggs, commonly called "nits," are about the size of a small pin's head, dirty white in colour, pitcher shaped and provided with a lid, or operculum, which is perforated with holes like the top of a pepper pot. Each egg is attached firmly to a hair or fibre by a very resistant cement excreted by the louse; this cement can resist the action of every known chemical and the only way to remove nits, other than shaving off the hairs, is by applying vinegar or kerosene oil to contract the hairs and then using a fine toothed comb or, in the case of clothing, a wire brush.

The eggs hatch in about a week, and between the egg and the adult stages a louse moults three times. The whole life cycle may be as short as 16 days under suitable conditions.

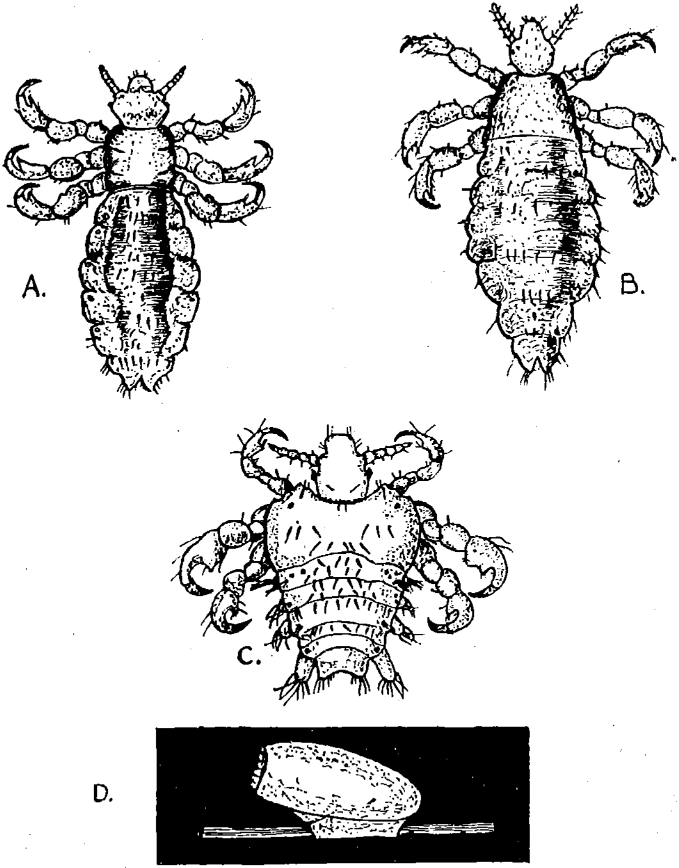


FIG. 55.—Lice.

(A) Head louse. (B) Body louse.
(C) Crab louse. (D) Louse egg attached to a hair.

Lice feed on blood and for this purpose they keep close to the human body, although they can exist for a week or even longer without feeding.

They are very susceptible to changes of temperature, and they will leave a dead body or a person suffering from fever ; they will also leave the body of a person suffering from jaundice.

Destruction of lice.—Effective measures for the destruction of lice must include both treatment of the person and treatment of infected clothing. Treatment of the person presents no difficulty and consists of stripping, removal of the body hairs and thorough washing of the whole body with hot water and soap or, better still, with an emulsion consisting of equal parts of olive oil and kerosene oil.

Treatment of the person is useless unless the clothing is treated at the same time, and the best method of killing lice and nits on clothing is by heat. Dry heat at 60° C. (140° F.) will kill lice and nits in half an hour, but will not kill disease germs conveyed by lice, so that steam disinfection is to be preferred. Lice may sham death and the only reliable sign of death is when they shrivel up and become brittle; dead nits shrivel up and collapse under dry heat or become opaque with moist heat.

Other less effective methods of dealing with lousy clothing are ironing with hot flat-irons, brushing with stiff wire brushes, application of preparations such as N.C.I. powder or Vermijelli, exposure to hot sun and hand picking (*see* Appendix 14).

Disinfestation should be carried out at intervals of not more than 14 days when lice are prevalent and should include every article of clothing as well as blankets, greatcoat and pack. Disinfestation is best carried out at an organized disinfestation centre.

Bed-bugs

Bed-bugs cause much inconvenience on account of the irritation and inflammation set up by their bites and the consequent loss of sleep, but there is no definite proof that they spread disease, although they are suspected of conveying relapsing fever, kala azar, plague and influenza.

The bed-bug is a small, flat, oval, wingless insect of a dull brown colour, and the name "mahogany flat" aptly describes it.

It is very nimble on its feet and walks rapidly, so that it can cover considerable distances. During the day it lives in cracks in beds, mosquito poles, furniture, walls and roofs, and at night it sallies forth in search of food, which is chiefly human blood. After a good meal it does not feed again for several days, although both adults and young can survive without food for long periods; there is no foundation for the belief that the bed-bug lives on the juices of moistened wood when unable to obtain human blood.

A particularly objectionable property of the bed-bug is the offensive smell which it gives off from its two stink glands, a smell which can readily be detected in bug-infested rooms.

Life history.—The female lays her eggs in cracks in the positions described above and also frequently behind the skirting boards of rooms, and returns repeatedly to the same place, so that eggs collect in masses.

The eggs are similar to those of the louse and are covered with a sticky substance, which holds them together. Even

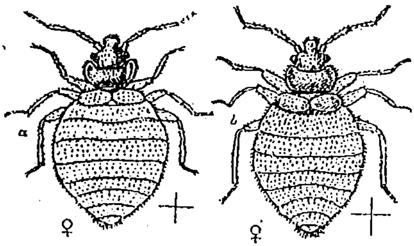


FIG. 56.—The bed-bug.

a. Cimex lectularius, the common bed-bug of the temperate zone; *b. Cimex hemiptera*, the bed-bug of the tropics.

N.B. + indicates actual size.

when the egg is laid, the young bug has partially developed inside it and in 4 to 9 days it hatches out and starts to feed at once if opportunity affords. The adult stage is reached in another 6 weeks and the total life cycle is about 7 weeks.

The mature female lives from 6 to 8 months and during her life she deposits about 200 eggs in batches of 20.

Prevention.—In new construction, much can be done to prevent infestation by getting rid of bed-bug harbourages in the replacement of wooden skirting boards and architraves by concrete and cement, of wooden window frames by metal ones and of wooden picture rails by special small picture-hanging nails, or, if absolutely necessary, a metal rail sunk in cement.

The walls and ceilings of rooms should, when practicable, be made of crack-resisting material.

In addition to lessening the risk of infestation, these measures limit its intensity should bed-bugs be introduced to a building, and make the eradication of the bed-bugs much easier of accomplishment.

The eradication of bed-bugs from infested buildings which are not constructed as described above, and especially from large rooms with high ceilings, is practically impossible short of thorough disinfestation with hydrocyanic acid gas. This gas,

if properly applied, kills the bed-bugs and their eggs. It is, however, very poisonous to human beings and animals and must therefore be used with the greatest care and only by experts.

Much can be done to diminish the degree of infestation by the personal efforts of the occupants of buildings, in whom habits of cleanliness of home and person should be inculcated, and who should receive instruction in regard to the life history and habits of the bed-bug and how to destroy it.

Other palliative measures consist in :—

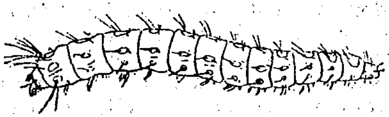
1. The use of sprays, many of which, good and bad, are on the market, and some of the best of which do kill the bed-bug if a sufficient quantity of the liquid actually comes in contact with the insect. Some of the more effective sprays also possess the property of bolting the bed-bug from its lair, thus enabling direct hits with the spray to be achieved. It is doubtful if any sprays at present available kill the eggs, and therefore spraying should be repeated twice, the final spraying being done twenty-one days after the first to ensure that young bed-bugs hatched out in the meantime are destroyed.
2. Disinfestation by formaldehyde gas, if carried out strictly in accordance with the directions given in Regulations for the Medical Services of the Army, 1932, para. 599, and repeated as in the case of sprays, gives good results only in small rooms with low ceilings.
3. Blow lamps are useful for the disinfestation of metal structures such as beds, while wooden beds can be boiled in a bed boiler, using a 5 per cent. solution of cresol.
4. Hollow cane mosquito net frames, in which bed-bugs are frequently found, should be replaced by metal ones.

Fleas

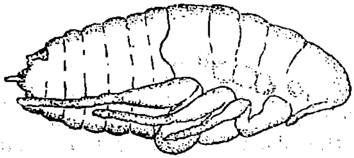
Rat fleas convey bubonic plague from infected rats to man. The flea sucks blood containing plague germs from an infected rat and then, when it bites a man, the wound becomes infected by plague germs regurgitated from the stomach of the flea.

Fleas are wingless insects with bodies flattened from side to side. They have difficulty in walking and move in jumps, which may be as much as 7¾ inches in height and 13 inches in length. When placed on fur or hairy cloth, such as a blanket, fleas bury themselves in the material and sham death.

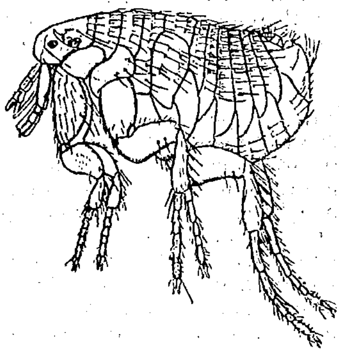
Life history.—The eggs are like very small pearls and can just be seen with the naked eye; they are laid singly in the dust in cracks in floors and in 2 to 10 days hatch out into small legless larvæ, which are bristly and wormlike. These larvæ



Larva. × 20.



Pupa. × 20.
Removed from its cocoon.



Adult (Male) × 20.

FIG. 57.—*Xenopsylla Cheopis* (Rat Flea).

feed on organic matter in the dust and many depend on partly digested blood passed in their parents' fæces.

The larva spins a cocoon, in which it remains until conditions are suitable for the adult to emerge. Moisture, the presence of human beings or animals on which to feed, and disturbance of the dust cause the adult fleas to emerge from the cocoon and account for the sudden increase in the number of fleas after rain or on occupation of a house that has long been unoccupied.

Prevention.—The first essential is cleanliness and the removal of dust. Floors may be scrubbed with a flea emulsion of soft soap, kerosene oil and water, and the corners sprinkled with powdered naphthaline or pyrethrum (Keating's powder) (*see* Appendix 14). Animals which harbour fleas, such as rats, mice and squirrels, must be destroyed ; domestic animals and pets, such as dogs and cats, and their bedding must be kept clean and free from fleas. Individuals may protect themselves by dusting their clothing and bedding with naphthaline or pyrethrum. Native quarters may be dealt with by burning dry grass or straw on the floors. Badly infested houses may be disinfested with hydrocyanic acid gas or formaldehyde gas.

Rats

Rats suffer from plague and, as already explained, the infection is carried to human beings by fleas.

Rattus rattus, the black domestic rat, is small and slender, has large translucent ears and a slender tail, which is as long or longer than the head and body together. It is a climber and not a burrower and therefore is usually found in walls, ceilings or roofs. Being a domestic rat, inhabiting human dwellings and ships, it is the one most concerned in the spread of plague.

Rattus norvegicus, the common brown rat, is larger and heavier, has small thick hairy ears and a stout tail, which is never as long as the head and body together. It is a burrower and a water lover and is more shy of human beings and their dwellings, so that it lives near river banks and sewers and is less concerned in the spread of plague.

No reliance must be placed on the colour in the identification of rats, as *Rattus rattus* may be distinctly brown, while *Rattus norvegicus* may have an almost black coat.

The staple food of rats is grain, but they will eat anything ; they usually make their nests near their food supply and keep to definite paths, or runs, on their journeys.

Rats breed all the year round but more commonly between January and June. The female comes on heat about every ten days, but this may only last a few hours and she will not be fertilized except during heat. The period of gestation is 3 weeks and the numbers in a litter may be from 5 to 14. Female rats are usually careful mothers, but they may eat their young if food supplies run short or if there is any disturbance from overcrowding in the nest.

Although plague is the most important disease acquired from rats, they may be the means of spreading epidemic jaundice, rat bite fever, dysentery and other intestinal

diseases, foot-and-mouth disease, horse influenza, and trichina spiralis in pork.

Prevention.—Measures should include the protection of food supplies and grain in rat-proof receptacles and stores; the collection of refuse in rat-proof receptacles, followed by removal and destruction; the rat-proofing of buildings, drains and ship's cables; and the destruction of the rats.

The destruction of rats must be systematic, rat campaigns being carried out in an area by every one simultaneously, working from outside towards the centre of the area. Methods for rat destruction consist of:—

1. Trapping.—Steel spring and wire basket traps are used successfully. When rat catchers are employed, payment should not be made on tails as this is apt to lead to fraud. Bird lime is sometimes used instead of spring traps.
2. Poisoning.—This should be carried out twice a year, in spring and autumn. A very good poison bait consists of one part of barium carbonate and eight parts of oatmeal mixed to a dough with water and made into pills. Other poisons which may be used are squills, phosphorus, and also cyanide and strychnine, but the two latter are very poisonous to man and must be used with great caution. In making up baits and in laying rat baits and traps, the greatest care must be taken not to handle the baits or traps with the naked hand, otherwise the rat will quickly detect the smell of the human being and will avoid the bait or trap. The fumigation of rat holes may be carried out with sulphur dioxide gas or the exhaust from a motor car.
3. Dogs.—Good ratting terriers will acount for a large number of rats.
4. Rodier system.—This consists of catching rats alive, killing the females and liberating the males. The result is that the males fight among themselves for the remaining females and the females are so much disturbed by the males that they cannot breed.

Mites

The itch mite (*Sarcoptes scabiei*) is not really a carrier of disease but, by the irritation of its burrowing in the skin, gives rise to the condition known as scabies, which, although a minor disability, may cause a great deal of inefficiency among troops and absence from duty; it also gives rise indirectly to boils and other skin infections as a result of scratching.

The female *Sarcoptes* burrows into the surface of the skin and lays 40 to 50 eggs, which hatch out in 2 to 3 days into larvæ; these larvæ burrow more deeply into the skin and cause the characteristic vesicles or pimples. The larvæ moult and become either mature males or immature females. The immature female makes a fresh burrow in which she awaits the coming of the male; after pairing the female moults, becomes mature and excavates a fresh burrow in which she lays her eggs. The total life cycle is from 9 to 15 days.

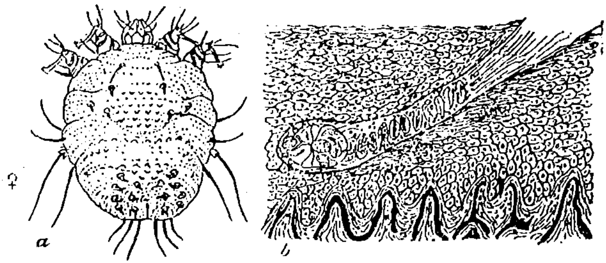


FIG. 58.—*Sarcoptes scabiei*. The "Itch" Mite.

a. Female mite; *b*. Female at the end of her burrow in the epidermis, with numerous eggs in various stages of development.

The irritation in scabies, which is worse at night when the warmth of the bed animates the parasite, is probably due to an acrid fluid secreted by the mite and is so intolerable that it induces scratching.

The burrows are commonly found between the fingers, but the crutch and genitals should also be inspected. Infection is usually by close personal contact and therefore the disease is closely allied to the venereal diseases.

Prevention consists of personal cleanliness, the treatment of infected persons and the disinfection of their bedding and clothing.

CHAPTER XI

DISINFECTION AND DISINFESTATION

Disinfection is the process by means of which disease germs are killed and thus rendered harmless.

Disinfestation is the process by means of which insects, or other vermin, which convey disease or cause annoyance, and their eggs, are destroyed or removed.

Methods employed in disinfection will be effective for disinfestation, but the reverse does not hold good. This can be understood if the difference between germs and vermin is considered; germs are very lowly forms of life capable of living under varying conditions, while vermin, such as fleas, lice and bugs, are much more complex creatures, which require special conditions for their existence and therefore are more easily killed.

The aim of disinfection and disinfestation is the same, namely, to break the chain of infection and thus prevent the spread of disease. Until recent years disinfection was directed to the destruction of germs in the air, but it is realized now that disinfection should aim at the true prevention of disease by destroying disease germs at their source rather than after infection has taken place; for example, in dealing with a man suffering from diseases such as influenza or diphtheria, both of which are spread by droplet infection, the room occupied by him, his clothing and bedding may be dealt with, but true disinfection would attack the source by the arrest and destruction of the infecting germs in the man's nose and throat before they had an opportunity to spread and infect other people.

When disinfection is carried out, it must be done systematically, and the objectives should be the sources and routes of infection of the disease in question; it must also be done thoroughly and not merely to impress people with the fact that something has been done.

On active service, disinfestation is more often necessary than disinfection, because troops become infested with vermin much more than in peace time. It must be remembered, however, that methods employed in disinfestation will deal with vermin such as lice but will not necessarily kill the disease germs conveyed by the vermin and, therefore, when there is any risk of an epidemic being spread by vermin, it is safer to employ disinfection.

The carrying out of disinfection is a matter for trained personnel, because failure to carry out any stage of the necessary proceedings will defeat the object in view; it is done, therefore, by the medical authorities assisted by such working parties from the troops as may be required, and the necessary materials are supplied by the officer i/c barracks. Holds and bilges on board troopships are disinfected by the crew.

The regulation measures and methods of disinfection and disinfestation are laid down in Regulations for the Medical Services of the Army, 1932, paras. 588 to 608 and Appendix 2.

Methods of disinfection and disinfestation

Physical or chemical agents are employed for disinfection and they are summarized below.

Physical Agents

1. *Light.*—Only the blue-violet and ultra-violet rays kill germs; the source of the light is not important but the germicidal action depends on the nature and intensity of the rays. Direct sunlight kills germs and is effective in hot countries such as India, but in Britain it is such an uncertain quantity that it cannot be relied on, except that well-lit rooms are more free from germs than those which are dark.

2. *Heat.*—Fire has always been considered the great purifier, but the burning of articles is often unjustifiable when other methods of disinfection can be employed. It is useful for destroying rubbish and articles of little value and is the best method of dealing with organic refuse and infected discharges from the body.

A. *Dry heat.*—A temperature of 150° C. for an hour will destroy all forms of life, including the spores of germs, but such heat cannot be applied to fabrics and similar materials, which are damaged by any temperature over 110° C.

Lice and their eggs are killed by 60° C. in half an hour, but this temperature is not sufficient to kill the attendant virus of diseases such as typhus and trench fever.

Radiant heat may be used from a source of direct heat such as a flat-iron. It is useful for freeing clothing from vermin, but care must be taken not to damage the material by too great heat.

Hot air may be used for the disinfestation of verminous clothing, but the temperatures, which will not damage materials, are insufficient for disinfection, especially when the germs present are spore-bearers or are protected by mucus and moisture, as in the case of discharges from the body.

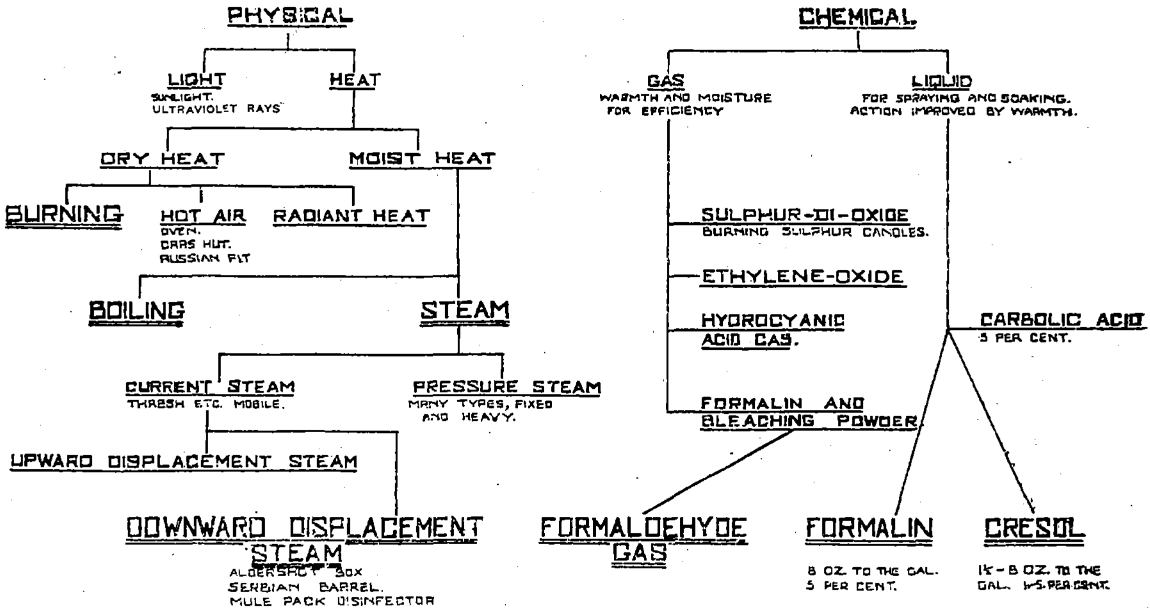


FIG. 59.—Methods of disinfection and disinfestation.

The temperatures at which materials are damaged by dry heat are as follows :—

Cotton wool turns brown and is damaged at 284° F. (140° C.).

White flannel becomes yellow and brittle in ½ an hour at 270° F. (127° C.).

White flannel becomes brittle but will recover after 240° F. (115° C.).

White flannel becomes yellow but retains its strength after 4 hours at 220° F. (104° C.).

Leather and fur are damaged by repeated exposure for ½ an hour at 176° F. (80° C.).

Leather and fur are not damaged at 140° F. (60° C.).

Hot air acts as a gas and its penetration is very slow ; dry air also is a poor conductor and therefore the heat does not spread. It is therefore only useful for the disinfestation of verminous clothing in the absence of disease, and for this it may be used in an ordinary baking oven, in Orr's hut or in the Russian pit dug-out

Orr's hut is constructed of corrugated iron, wood or even tent material. The walls and roof are double and the space between is packed with earth or other non-conducting material. The floor is of metal (corrugated iron) in which numerous holes are made to allow the hot air to rise from a pit under the floor ; in this pit are placed a number of braziers to act as the source of heat. Garments for disinfestation should be hung up loosely in the chamber to give the hot air every chance of reaching and killing the vermin. Thermometers should be used to ensure that the temperature in the chamber reaches from 140° F. to 160° F. (60°–71° C.).

Fur, leather and books are not likely to be seriously damaged, but articles containing rubber, wax or gum should not be dealt with in this apparatus. Personnel must be warned against the danger of poisoning by carbon monoxide gas from the braziers.

Dug-out disinfestor.—This consists of a " dug-out " with an annexe. The fire box is in the annexe and heats a large flue, which passes through the chamber ; the fumes pass up this chimney and do not enter the chamber. Garments must be hung up loosely and the temperature in the chamber must be controlled by a thermometer.

B. *Moist heat.*—Boiling will kill immediately all disease germs except a few spore bearers. It is very useful for disinfecting crockery, utensils, towels, linen, etc., but it fixes stains in fabrics, which should therefore be soaked before being boiled.

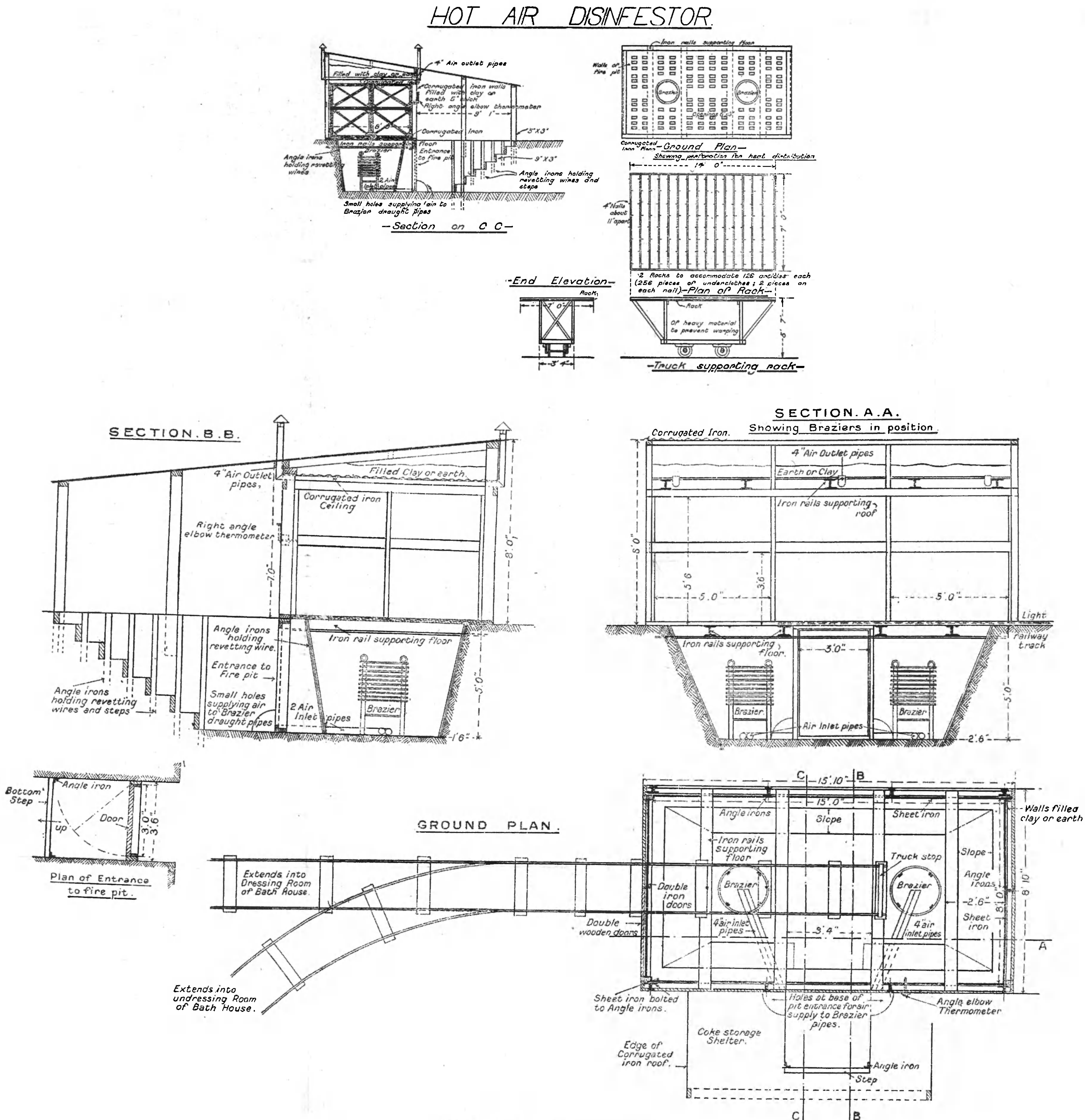


FIG. 60.—Orr's hut. Hot air disinfestor.

Steam is the most useful disinfecting agent, because it is reliable, quick and penetrating, but it has the disadvantage that it ruins leather, fur, webbing, rubber and anything con-

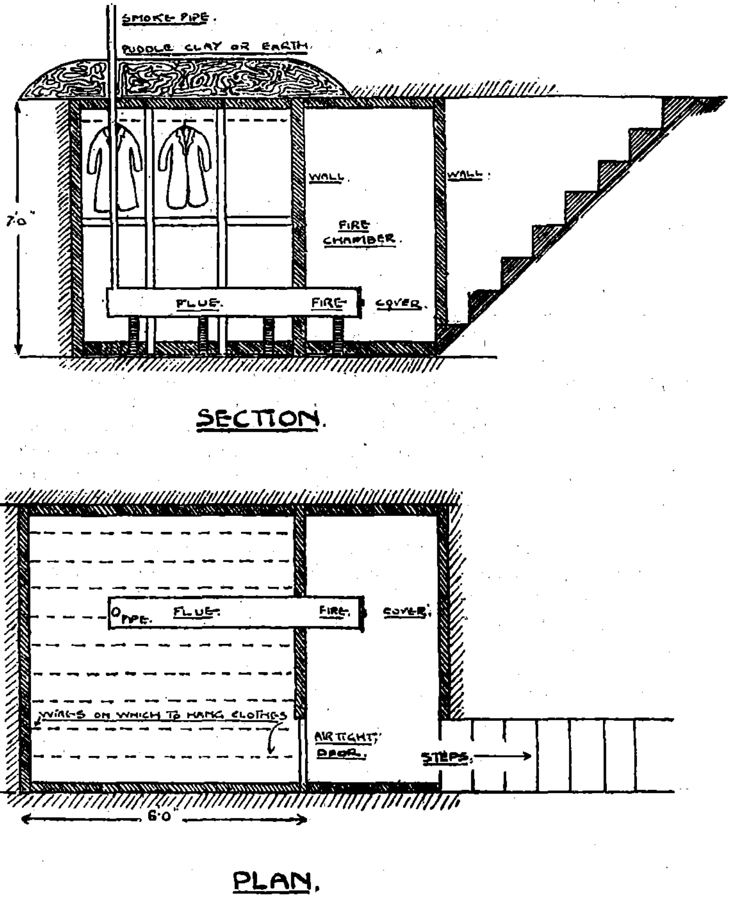


FIG. 61.—Dug-out hot air disinfestor.

taining wax, glue or varnish. It is used either as current steam or pressure steam.

Current steam is the same as that which emerges from the spout of a boiling kettle and it has a temperature of 212° F. (100° C.), the same as that of boiling water.

Pressure steam is that generated in a confined space under pressure; it has a higher temperature and is therefore more effective than current steam, but it requires more complicated apparatus.

BOILING POINT OF WATER AT VARIOUS PRESSURES

Above ordinary atmospheric pressure	Pounds to square inch	Temperature	
		Centigrade	Fahrenheit
0 atmosphere ..	0	100	212
⅓ ,, ..	5	109	228
⅔ ,, ..	10	115·5	240
1 ,, ..	15	121·5	251
1⅓ atmospheres ..	20	126·5	260
2 ,, ..	30	134	273
	40	141·5	287
3 ,, ..	45	144	291

1 atmosphere = 29·9 in. of mercury = 14·7 lb. to the sq. in.

Superheated steam is steam of which the temperature has been further raised without increasing the pressure, as may be done by bringing the steam into contact with a surface hotter than the temperature of the steam; such steam is in the form of a gas and as such it is a bad conductor of heat and has low powers of penetration, so that it has no advantages over current steam.

Whether current or pressure steam is used the air in the disinfecting chamber must first be expelled as air is a poor conductor of heat and forms dead spaces, thus preventing the steam coming in direct contact with the articles to be disinfected.

The maximum effect from current steam is obtained when "downward displacement" is used, whereby steam is admitted at the top of the chamber and drives out all the air in front of it as it descends, so that the chamber is completely filled with steam and no pockets of air are left.

In older types of disinfectors "upward displacement" was used, that is, steam was admitted at the bottom of the chamber. This method is uncertain in action and not so effective as downward displacement, because the steam finds its way up through the chamber by the lines of least resistance, leaving pockets of air, which cause delay in the heating of the materials and consequently incomplete disinfection.

Downward displacement has the further advantage of exerting a certain amount of pressure on the steam in forcing it downwards through the chamber.

The value of steam depends on its latent heat and its penetration.

Downward Displacement of Steam. Upward Displacement of Steam.

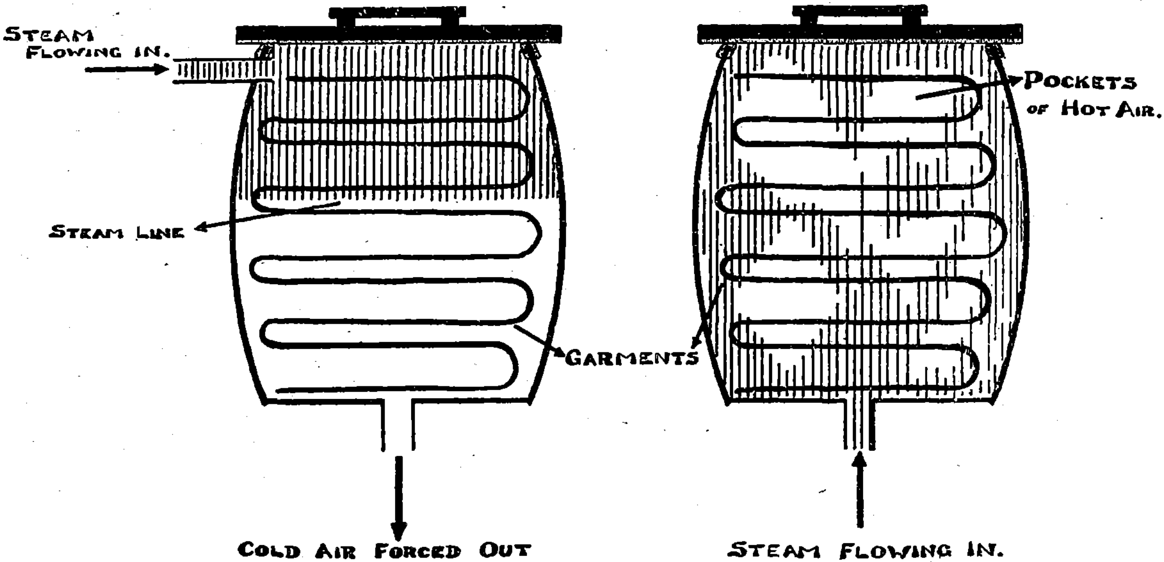


FIG. 62.

Latent heat is the amount of heat given up or absorbed by a substance in changing its physical state. At ordinary atmospheric pressure 537 calories of heat are absorbed in converting one cubic centimetre of water into steam; when the steam is condensed to water again by coming into contact with colder objects, it imparts its latent heat (537 calories per gramme) to those objects, with the result that they become heated suddenly.

The penetration of steam is due to its powers of expansion and contraction. When water is converted into steam, it expands so that the steam occupies about 1,700 times more space than the water; similarly, when steam condenses to water, it contracts to $\frac{1}{1,700}$th part of its former volume.

During the process of steam disinfection, the steam admitted to the chamber condenses and gives up its latent heat; as a result of condensation it also contracts and causes a vacuum in the chamber, into which more steam is sucked, more latent heat is given up and the heat penetrates throughout all the materials in the chamber.

The temperature of the boiling point of water, and consequently of the steam produced, may be raised by adding certain salts to the water, and so long as the steam is in contact with such boiling solution it maintains its raised temperature. This method of using salts for raising the boiling point is applied to certain forms of disinfector.

Pressure steam is employed in disinfectors of many makes. The types of apparatus are elaborate, expensive and require trained personnel to work them. (*See* Appendix 15.)

For the purposes of disinfection in the field, current steam with downward displacement is used and is employed in less elaborate, less expensive and lighter forms of apparatus suitable for transport, improvisation and easy repair.

Field disinfectors

The Serbian barrel.—This apparatus may be improvised from a barrel or similar receptacle to be used as the disinfecting chamber, a 5-gallon oil or cresol drum for a boiler, and some short lengths of piping.

The lid of the barrel is padded with old blanket, or similar material, so that, when placed in position, it is practically steam tight. A hole is made near the top of the barrel for the insertion of the steam inlet pipe, a second hole being made in or near the bottom for the escape of steam. The drum to be used as a boiler has two pipes inserted on one side. The first pipe extends inside the drum to within about 1 inch of the other side and to a height of about 18 inches outside; this is used for filling and also acts as a safety valve when the boiler

is in use. The other pipe, which only passes a short distance into the boiler, has an elbow bend and carries steam from the boiler to the barrel.

When the parts are ready, the barrel is sunk into a convenient

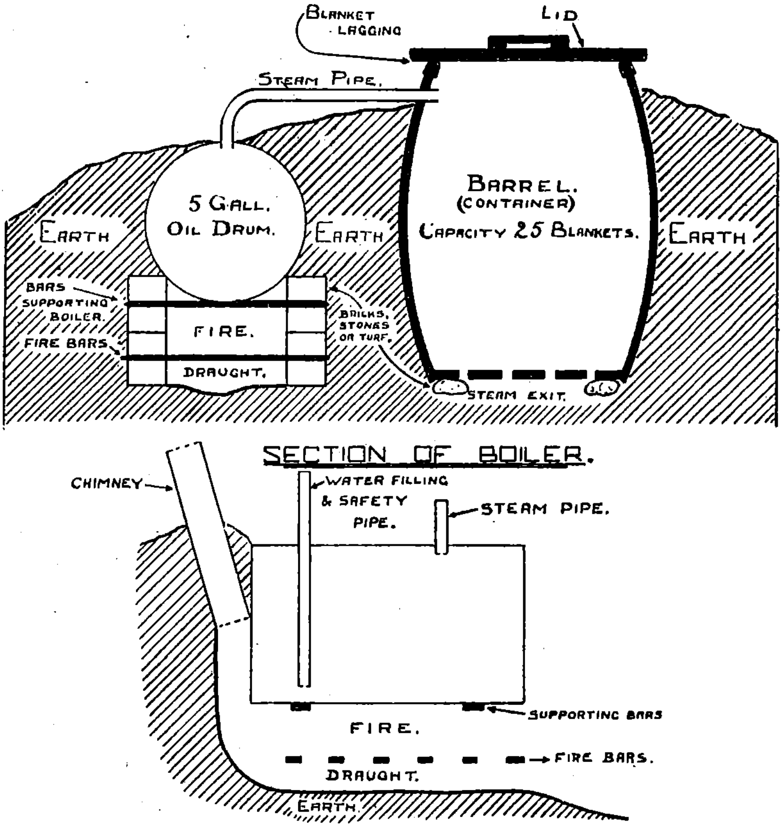


FIG. 63.—Serbian Barrel Disinfector.

Downward Displacement.

bank or is heaped round with earth to conserve heat, care being taken to allow for the free escape of steam from the opening at the bottom. The oil-drum boiler is placed over a trench fire and filled with water, the steam pipe being inserted

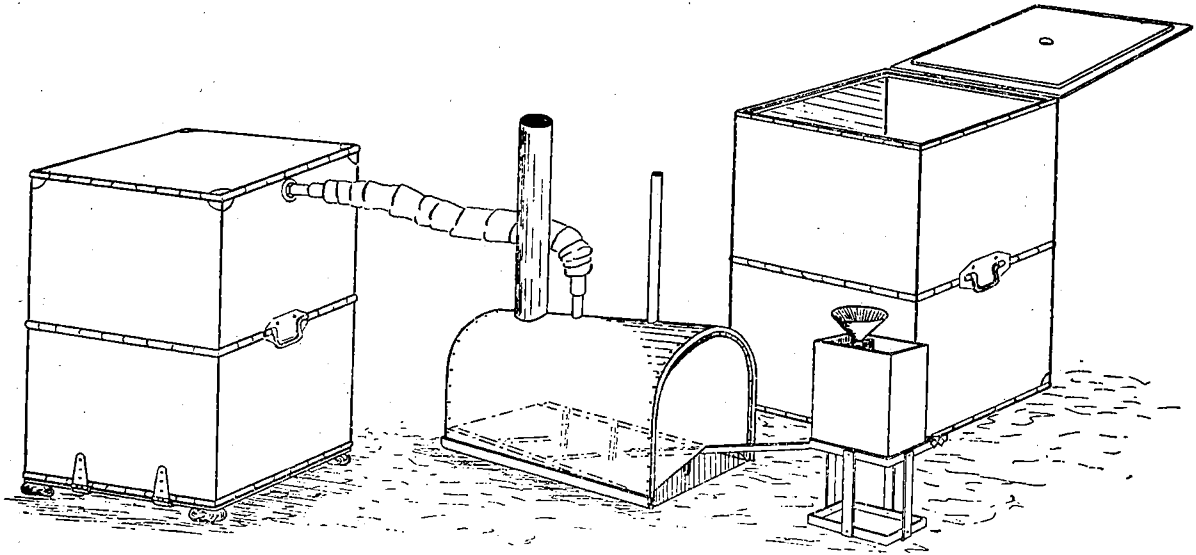


FIG. 64.—Mule Pack Disinfector.

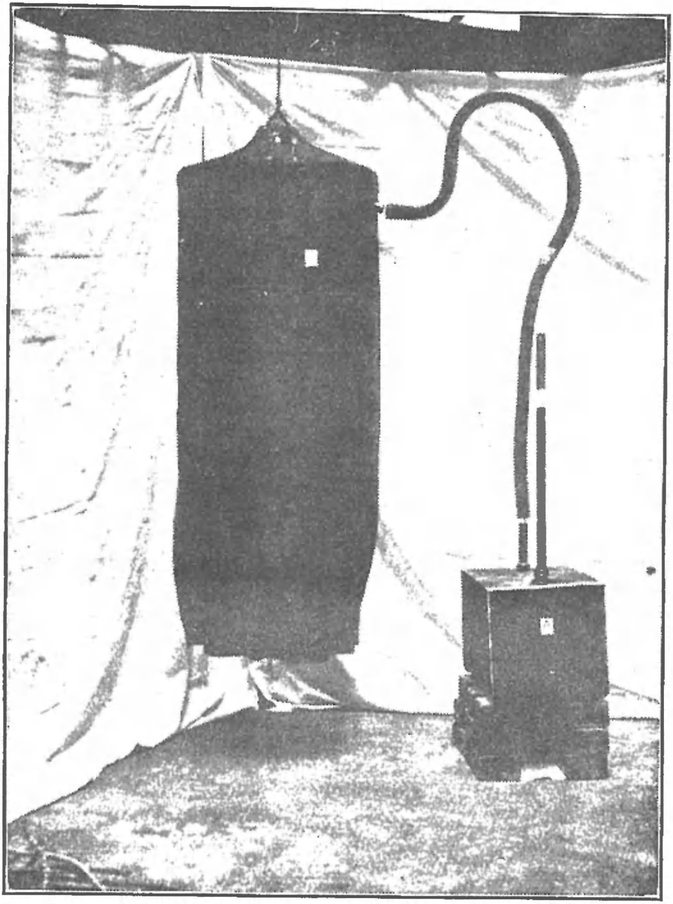


FIG. 65.—Lelean sack steam disinfector. (Downward dis placement current steam.)

into the barrel through the opening near the top. In an improvised apparatus the pipe joints can be wiped with clay.

Packing case disinfector.—This may be made with any tin or zinc-lined packing case on the same principles and with a boiler as in the Serbian barrel. The case and its lid should be lagged all round with old blanket between the wood and the tin or zinc lining.

Mule pack disinfector.—The object of this apparatus is to provide units and small detached forces with a portable, inexpensive and easily worked disinfecting plant. The apparatus is designed to be complete in one mule load and suitable for pack transport.

It comprises two oblong boxes of light wood lagged with blanket and lined with light metal, each being provided with a hole near one end for the steam inlet pipe and another hole at the other end for the escape of steam. Steam is obtained from a simple oil-drum boiler heated by an oil and water flash fire and is led by a flexible pipe to the box; disinfection is by downward displacement.

While one box is in use, the other is being packed with materials requiring disinfection, and, when disinfection is completed in the first box, the steam pipe is connected to the second box, the contents then being removed from the first box and shaken vigorously to dry them.

About 27 blankets an hour can be disinfected with this apparatus.

Lelean sack disinfector.—The Lelean sack is a compact, portable and reliable disinfector for indoor use, but the material of which it is made tends to crack after being folded repeatedly and must therefore be coated frequently with a special paint to render it steam-tight. It has insufficient insulation for outdoor use in cold climates.

Steam is supplied from a boiler and is conveyed by a flexible hose to the closed end of the sack. The sack is filled, inverted and hung up so that steam enters at the upper end (downward displacement). Disinfection is complete when steam has issued freely from the lower end of the sack for two minutes.

Crockery disinfector.—The steaming drum is made from a five-gallon oil drum with the top and its handle and filler hole left in place, but with the bottom removed. A conical wooden plug, the jet block, is fitted into the filling cap of the drum, and a half-inch metal pipe passed through the jet block as a connection for the hose-pipe. (*See* Fig. 66.)

35 to 40 plates and 8 to 12 mugs are washed, inverted and piled in groups on a wash-up table. With steam up, the steaming drum, fitted with a jet block, is placed over a pile of

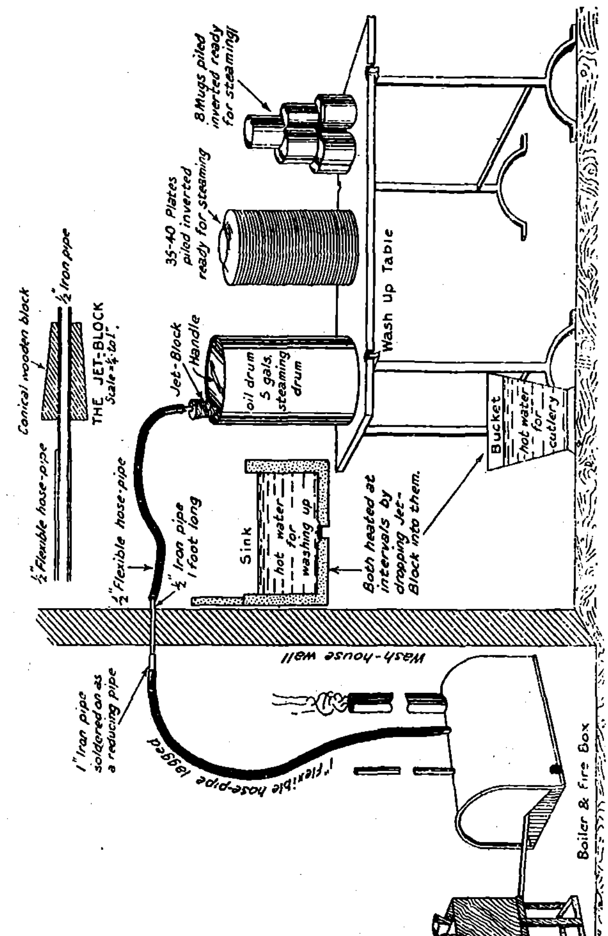


FIG. 66.—Crockery disinfection (diagrammatic).

articles. Two minutes after steam appears from below the lower edge of the drum, disinfection should be complete. The steaming drum is removed and the articles will dry rapidly without being moved.

The steam jet can also be used for heating up and periodically maintaining the heat of the water in the wash-up sink or

bucket for cutlery. Four gallons of water can be heated from cold (6° C.) to over 80° C. in ten minutes.

Chemical agents

1. *Gases*

Disinfection by means of a gas is useful for rooms, but it is not so effective for clothing or bedding, as the gas has little power of penetration. Success is greatest when a large volume of gas is produced in a short time and when the atmosphere is moist and warm. The room or parts of a building to be treated must be sealed to prevent the escape of gas; all apertures, including the door used by the working personnel, must be sealed and special rolls of gummed paper are issued for this purpose.

A. *Formaldehyde.*—This is the gas which is most used, as it is a very effective germicide and is easy to use. It is not highly dangerous, as its presence can easily be detected; moreover, it does not cause discoloration or destroy leather, fur, rubber or webbing.

It is produced by the action of bleaching powder or potassium permanganate crystals on formalin, and the method employed is to place the formalin in a three-gallon bucket and to drop into it paper bags containing the bleaching powder or potassium permanganate crystals; much frothing occurs and the receptacle should therefore be deep. Two pints of formalin and two pounds of bleaching powder or one pint of formalin and two and a half ounces of potassium permanganate are required for every thousand cubic feet of space, and not more than these amounts should be placed in any one bucket or the solution may froth over.

Formaldehyde gas is effective for the eradication of bugs and lice from small rooms but should not be used for large rooms. To ensure success the directions given in Regulations for the Medical Services of the Army, 1932, para. 599, must be carried out in detail; the temperature of the room must be raised to 70° F. and the relative humidity to 70 per cent., and the receptacle in which the gas is generated must be placed at a height of not more than 6 feet from the ceiling.

B. *Hydrocyanic acid gas.*—HCN gas, as it is called, is very effective for the destruction of vermin, but it is a weak germicide and therefore it is chiefly used for disinfesting buildings and for the eradication of rats from ships and granaries. Hydrocyanic acid gas is very poisonous and, being colourless and odourless, it gives no warning of its presence; so, as a measure of safety, it is usually mixed with tear gas to indicate its presence.

The use of this gas is limited on account of its poisonous nature, but certain less dangerous forms of it are coming into use.

C. *Sulphur dioxide gas.*—Fire and brimstone have been used for centuries to purify the air in which the vapours of disease were supposed to be present. Sulphur dioxide gas is obtained by burning sulphur; it is not very effective against germs, but it is very poisonous to the larger vermin and therefore is chiefly used for the deratization of ships and buildings.

It is a heavy gas, which bleaches colours of vegetable origin and also some aniline dyes; it discolours metal and damages foodstuffs, cotton and linen fabrics, and on account of these disadvantages it has little to recommend it as a disinfectant. Sulphur dioxide gas, pumped into rat holes by means of a Clayton blower, is a most useful method of exterminating rats.

D. *Ethylene oxide gas.*—Experiments have been carried out recently with ethylene oxide gas and it is said to be a very powerful disinfectant. By itself it has an explosive action and it is therefore mixed with carbon dioxide gas, which makes it safe; the mixture is in the proportion of one part of ethylene oxide to nine of carbon dioxide and is known by the trade name of carboxide. This is supplied in liquid form in steel cylinders, from which it is released as a fine spray, which produces a colourless gas with a faint ether-like smell. It is reported to have remarkable powers of penetration and to be less dangerous than hydrocyanic acid gas.

2. *Liquids*

Cresol is the most universally used liquid disinfectant for general purposes. It forms a good emulsion with water, but, when it is to be used with sea water, it should first be emulsified with five to ten times its own bulk of fresh water and then added to the required amount of sea water.

There is always a tendency to use cresol in much stronger solutions than necessary and thereby cause unnecessary waste. The usual strength for general purposes is 1 per cent. (1½ ounces to the gallon of water) but, if the time for disinfection has to be decreased, the strength may be increased to 2½ per cent. (4 ounces to the gallon) or even 5 per cent. Infected clothing and bedding is soaked in 2½ per cent. cresol for half an hour or packed in sacks or sheets soaked in the same solution and removed to a steam disinfector.

Formalin is a 40 per cent. solution of formaldehyde gas and is a very effective disinfectant. It is used for the generation of formaldehyde gas, as already described, and also for spraying rooms and articles likely to be damaged by steam. When used for spraying, 8 ounces of formalin are added to a

gallon of water and one gallon of this solution should be used for every 400 square feet of surface to be disinfected; the solution acts by direct contact of the dissolved formaldehyde and by volatilization of the gas from the wetted surfaces. Wall surfaces must be sprayed from below upwards to ensure complete disinfection of the whole.

The daily spraying of rooms with formalin is a useful preventive measure against influenza, common colds and other droplet infections when such diseases are prevalent. A weak solution of formalin is sprayed round beds, fireplaces and other places where men congregate and also on door handles, fire irons and other articles handled by the men; this is done every morning as soon as the men leave the barrack room, the windows being kept shut during spraying and opened afterwards.

Carbolic acid is used mainly for surgical purposes in a 5 per cent. solution.

Mercury.—Solutions of the biniodide are used for disinfecting the hands but are of little value for general purposes. The perchloride (corrosive sublimate) should not be used, as it corrodes metals and also coagulates albumen and prevents the disinfectant penetrating the coating thus formed.

Lime.—Chloride of lime (bleaching powder) in solution is used for purifying drinking water, but the practice of sprinkling powdered chloride of lime in drains and round latrines with the object of achieving disinfection is useless.

Quick lime, freshly slaked, is a very good disinfectant and is used for lime-washing walls, stables, stands for refuse bins and other such places which are liable to fouling. It should be used with a view to disinfection and not merely for the sake of appearance. Powdered quicklime is used in the disposal of carcasses of infected animals.

Military methods of disinfection

Disinfection may be complete, local, or special.

Complete disinfection consists in the disinfection of a whole room and its contents. Local disinfection consists in the disinfection of the bedstead and bedding recently used by an infectious case, the walls, floor and other surfaces for a distance of six feet all round the bed and of all articles within this area, including the equipment and locker and its contents.

Special disinfection is carried out for special articles such as bedding, clothing, towels and handkerchiefs in the case of venereal diseases, or eating and drinking utensils in the case of diseases spread by droplet infection.

Rooms.—Disinfection is carried out by spraying with formalin and disinfestation by means of formaldehyde gas generated from formalin and chloride of lime.

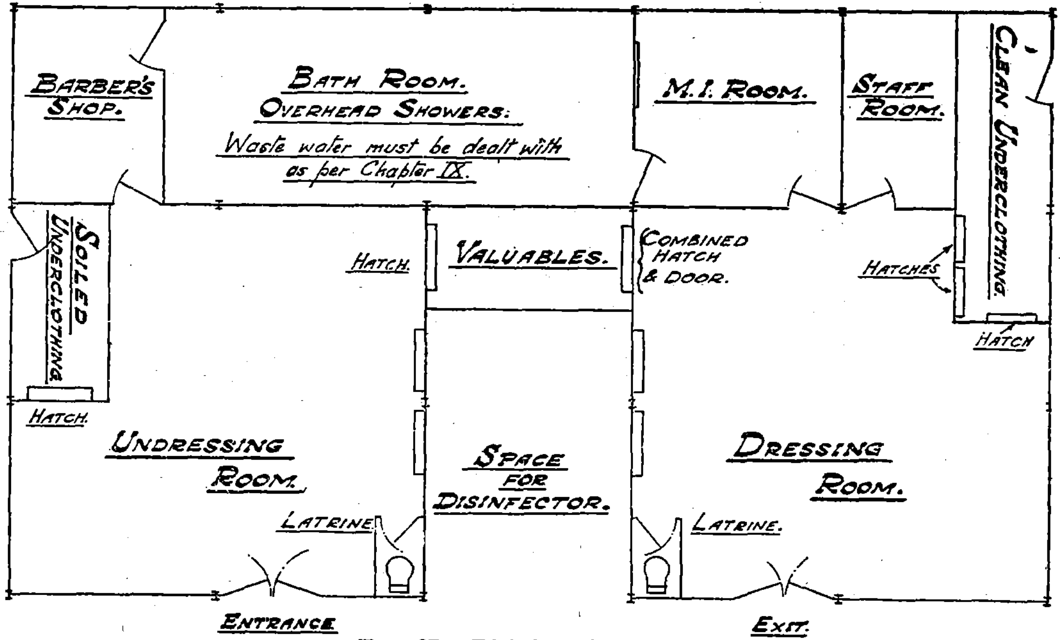


FIG. 67.—Disinfestation centre.

Clothing, bedding and equipment.—All articles not likely to be damaged in the process are disinfected by steam. Leather goods, clothing with leather strappings, furs, rubber, webbing and books are sprayed with formalin.

Disinfection centre

The area or building to be used as a disinfection centre should be divided into a "dirty" side, on which infected articles are received, and a "clean" side for the disposal of disinfected articles; these two sides should be completely separate and the only communication between them should be through the disinfector.

Arrangements should be made on the dirty side for disinfecting the vehicles used for the transport of infected materials, and personnel employed in handling infected materials must be suitably protected against infection.

Storage accommodation should be available on the clean side for disinfected articles until they can be removed.

Disinfestation centre

Troops on field service are liable to become infested with vermin and should be disinfested periodically; this can best be done in a disinfestation centre, where facilities are provided for bathing, the supply of clean underclothing and the disinfestation of outer clothing, blankets and equipment.

A disinfestation centre, like a disinfection centre, should be organized so that there is a dirty arrival side and a clean departure side, progress from the former to the latter being through the bath room for personnel, the laundry for underclothing and the disinfector for other articles.

The method of laying out a disinfestation centre can best be understood by reference to the diagram shown in Fig. 67, but modifications of all kinds will, of course, have to be made to suit local requirements. Disinfestation will not be effective unless infested men are separated from clean men, and it may be necessary to employ regimental police or special enclosures to keep them apart.

CHAPTER XII

NOTES ON IMPORTANT DISEASES AND THEIR PREVENTION

The object of this chapter is to give a brief account of the means of spread and methods of control of those preventable diseases which are most liable to cause wastage in the Army. They are divided into groups according to the classification given in Chapter I.

Group 1. Excremental diseases

Excremental diseases are diseases of the intestines ; infection by the germs starts in the intestines and the germs are passed out of, or excreted from the body in the fæces alone or in the fæces and urine. The germs in the excreta are transferred to food and water supplies by flies, dust, sewage or hands.

The prevention of this group of diseases is by means of good sanitation, the protection of food and water supplies from contamination and the destruction of the germs as early as possible by efficient methods of disposal of excreta.

Cholera

Cholera is endemic in India and China, from which countries it spreads along lines of communication and trade routes. In the past it has caused great mortality among troops ; for instance, it killed 10,000 British and French troops during the Crimean War, and it still destroys immense numbers of the native populations of Eastern countries, where no community is safe from an epidemic if sanitary care is relaxed.

Cholera is due to a comma-shaped bacillus, called a vibrio, which causes an intensely acute inflammation of the intestines. The germs are usually swallowed in water, although infection may be by food, dust or articles of clothing or bedding soiled by discharges from patients suffering from the disease.

After an incubation period varying from a few hours to ten days the disease generally comes on very suddenly, although it may begin with only a slight diarrhœa. There is violent purging and vomiting with passage of stools and vomit resembling rice water, severe and painful cramps, and marked collapse, with the face becoming pinched and grey and the body very cold. Many of the symptoms are due to the excessive loss of fluid from the body, but there is a dry type

in which there is little or no diarrhœa. Recovery is often rapid in favourable cases, but in others death may occur in a few hours. Mild cases occur, especially towards the end of an epidemic, but such cases are also infective.

The germs are passed in the fæces and vomit and may live outside the body for several weeks in water, earth and shell-fish, and on soiled clothing. Carriers are common among convalescents; during epidemics many apparently healthy persons are found to be carriers and any cause of diarrhœa in such a person, as from a dose of purgative medicine, may bring on an attack of cholera.

Preventive measures.—1. The maintenance of the men's morale and keeping them active and fully employed. This is one of the first necessities, as cholera is an alarming disease and frequently attacks those who, on account of fear, have their vitality lowered.

2. The immediate isolation of cases and the strictest attention to the disinfection of their discharges and soiled materials.

3. The protection and purification of all water supplies. The addition of thirty drops of dilute hydrochloric acid to each pint of drinking water is useful. Dairies and mineral water factories must be closely supervised. Washing at or near drinking water supplies must be prohibited.

4. The protection of food and special control of personnel employed in kitchens, institutes, refreshment rooms and other places where food is prepared or handled in any way. Only licensed hawkers, who, with their wares are under supervision, should be permitted to enter barracks. Milk should be boiled and no shell-fish or vegetables, or fruit not requiring peeling, should be eaten raw.

5. The exclusion of carriers from any duties connected with food and water, with special attention to institutes and refreshment rooms.

6. Anti-fly measures and conservancy methods to prevent the possible pollution of water and food supplies.

7. Inoculation.—This gives protection for two to four months and should not be done until the need arises. Contacts with cases should be inoculated and segregated.

Diarrhœa

There are two types of diarrhœa—an infective epidemic type and a non-infective. The infective type is due to germs similar to those of dysentery and spreads in the same way.

Simple non-infective diarrhœa is due to irritation of the bowels by indigestible and unsuitable foods, unripe and over-ripe fruit and vegetables, or by sand, mud and dirt in the food

P.636.—7.

or drinking water. Although simple diarrhœa is not as a rule dangerous to adults, it may cause considerable inefficiency among troops and is indirectly the cause of losses to an army marching through hostile country, where men who have to fall out on account of diarrhœa are liable to be cut off by the enemy.

Infective or infantile diarrhœa is usually due to bacillary infection through water or milk and may cause many fatalities in soldiers' families.

It must be remembered that diarrhœa may be a symptom at the start of many diseases such as typhoid fever, dysentery and cholera and it is therefore of great importance that men suffering from diarrhœa should report sick at once, particularly in the tropics.

Preventive measures consist of the use of clarified and purified water for drinking, the protection of food and water supplies from flies, dust and dirty hands, and the prohibition of the sale of unsound and unsuitable fruit and vegetables.

Dysentery

There are two forms of dysentery, namely, amœbic and bacillary; the former is caused by parasites called amœbæ and the latter by bacilli. They both cause disease of the intestines and both the amœbæ and the germs are passed out of the body in the fæces, but not in the urine.

Bacillary dysentery is commonly spread by contaminated water and by flies, and usually appears in epidemic form. Amœbic dysentery is usually spread by flies, hands and dust, and appears more irregularly. The incubation period is from one day to a week in the bacillary type and uncertain, anything from three to twelve weeks, in the amœbic type. The onset is usually sudden and the symptoms are similar in both types, there being pain in the bowels, constant desire to go to stool, severe straining and the passage of blood and slime and later of shreddy material due to acute inflammation and ulceration of the large intestine.

The disease often becomes chronic and carriers are common. One attack does not protect from further attacks.

Dysentery has been prevalent in all wars and is the cause of great losses to armies. Some notable examples of these losses have occurred in the British Army; for instance, the army of Henry V before the battle of Agincourt, 1415, was decimated by dysentery; in the Crimea, 1854, the whole force was considerably weakened by the disease, while in the South African War, 1899–1902, there were 38,108 cases and 1,342 deaths from dysentery (68·60 and 2·42 per 1,000 of the strength respectively). In the Great War, dysentery appeared in acute form in the Eastern theatres of the war.

DYSENTERY IN THE BRITISH FORCES IN THE GREAT WAR, 1914–1918

Campaigns	Admissions	Deaths	Ratios per 1,000	
			Admissions	Deaths
France and Flanders	26,432	160	4·26	0·03
Italy	901	17	9·52	0·18
Macedonia	24,245	480	46·21	0·90
Dardanelles	29,728	811	253·94	6·93
Egypt and Palestine	14·844	484	24·76	0·77
Mesopotamia ..	42,995	622	67·54	0·90
North Russia ..	14	—	1·28	—
East Africa—				
Troops	22,241	821	279·83	5·61
Followers ..	44,142	8,966	91·86	23·70
S.W. Africa ..	715	13	21·67	0·39
United Kingdom ..	2,049	5	0·26	0·00
Total forces ..	208,206	12,379	78·83	3·94
Total troops, excluding followers ..	164,064	7,413	70·92	1·94

Prevention.—The spread of infection in dysentery results from the contamination of food, water or other articles or of the hands with the excreta of patients or carriers.

Preventive measures should include the following :—

1. The protection and purification of water supplies.
2. The protection of food from flies, dust or sewage contamination, special attention being paid to milk, fruit and vegetables.
3. The exclusion of carriers from any duties concerned with food or water. In tropical countries, natives employed in institutes and refreshment rooms are frequently found to be carriers.
4. The exclusion of flies from excreta and disposal of fæces and urine in such a way that water and food supplies will not be contaminated.
5. The careful cleansing of the hands before meals.

Protective inoculation against bacillary dysentery has been introduced but is still in the experimental stage.

Schistosomiasis

Schistosomiasis, or " Bilharzia " disease as it is sometimes called, is widespread in Africa and the natives of Egypt are heavily infected with it; it is also found in Mesopotamia and the West Indies.

The disease is due to a species of worm, the Schistosome, which spends part of its life cycle in man and part in a fresh-water snail.

Man is infected from water from which free swimming forms of the worm penetrate the skin or the lining membrane of the mouth. The worms live and breed in the large blood vessels and their eggs are passed out in the urine and fæces. The eggs are furnished with spines and the irritation and injury produced by the eggs give rise to the symptoms of the disease.

The eggs hatch out in fresh water and infect certain water snails, in which they produce enormous numbers of young forms called "cercariæ," which in turn escape into the water and attack human beings.

Prevention.—Infection is from water and any water which may possibly be infected must not be used for drinking, washing or bathing. Ordinary chlorination of drinking water cannot be relied on and at least twice the normal amount of water sterilizing powder must be used.

After preliminary clarification cercariæ can be killed and water rendered safe for drinking in one hour by treatment with a standard dosage of chloramine. The standard dose for 100 gallons of water, for use one hour after treatment, is two tablets of ammonium chloride followed by two scoopfuls of chlorosene.

By doubling the standard dosage cercariæ in clarified water are killed in half an hour.

Acid sodium sulphate, 1 in 1,000, will kill the cercariæ at once ; two 15-grain tablets should be used in a quart of water. Boiling is effective but cannot be carried out on a large scale. Storage of water for 48 hours is effective, provided it contains none of the snails, which can be removed by straining the water through 16-mesh wire or muslin gauze before it enters the storage tanks. Snails must be excluded from bathing and washing water, which can be rendered safe for immediate use by the addition of cresol, 1½ ounces per 100 gallons of water (1 in 10,000).

If the water is kept overnight 1 in 90,000 is sufficient.

Typhoid and Paratyphoid Fevers

These diseases resemble each other closely and can therefore be considered together. Typhoid fever is caused by the typhoid bacillus and the paratyphoid fevers by the paratyphoid bacilli. The germs enter the body by the mouth, usually in water, milk or food, and after an incubation period of 8 to 21 days the disease comes on, usually gradually. Ulceration of the bowels is the distinguishing feature, with continued fever and great weakness. The disease lasts from 3 to 5 weeks but relapses may occur.

The germs are found in large numbers in the urine and fæces during all stages of the disease and even during convalescence; some persons continue to pass the germs for years after recovering from the disease and while in apparently perfect health, such persons being called " carriers."

During an epidemic, persons who appear to be quite well may harbour the germs and be passing excreta full of infective germs. Also, during an epidemic, mild cases occur, so mild that the men do not feel ill enough to report sick, but are nevertheless spreading the germs. Search must therefore be made for carriers and any man who is at all indisposed should report sick at once, especially if he has diarrhœa.

Typhoid and paratyphoid fevers are common all over the world. After dysentery they are the most important diseases affecting soldiers in the field and no force of any size is likely to remain entirely free from them. These diseases have been a constant scourge of armies, especially in hot countries, and make their appearance whenever sanitary arrangements are inadequate.

Preventive measures.—Typhoid and paratyphoid fevers are spread by anything contaminated by the urine or fæces of patients and carriers, so that there must be strict attention to cleanliness and rapid disinfection of all excreta and all utensils, bedding, clothing or other articles soiled by patients. The germs are frequently conveyed by the hands, which therefore should always be washed before meals, special attention being paid to the finger nails.

All water should be regarded as unsafe and should be purified before being used for drinking; this should apply also to aerated waters, and the sale of aerated waters and other drinks from unauthorized sources should be prohibited.

Food must be protected from flies, dust, and contaminated water. Special precautions should be taken against the adulteration of milk with polluted water, and in the tropics all milk should be boiled.

In hot countries vegetables, especially lettuces, are a source of danger and should not be eaten uncooked, and only fruit which can be skinned, such as oranges and bananas, should be eaten raw. Oysters and other shell-fish may be contaminated with sewage and should be avoided, unless the beds from which they are taken are known to be unpolluted.

Typhoid and paratyphoid germs can live in ice, which should therefore never be put in drinks if there is any possibility of the water from which it is made having been polluted.

Cook-house sanitation and the cleanliness of cooks must be of the highest standard. No person who has suffered from typhoid or paratyphoid fever will be employed in the handling

or preparation of food or purification of water, and all persons so employed should undergo laboratory examinations to ensure that they are not carriers.

Anti-fly measures should be carried out, especially during epidemics, and special precautions must be taken to prevent the access of flies to excreta and food.

Conservancy measures must ensure the rapid and complete disposal of all excreta in such a way that water and food supplies are not contaminated.

Inoculation is the outstanding method of protection against attacks of typhoid or paratyphoid fevers, especially in the case of young officers, soldiers and families proceeding abroad for the first time. Protection lasts from one to two years and, to ensure full protection, inoculation should be carried out at least three weeks before any special period of risk.

Group 2. Droplet infections

The germs of these diseases live in the nose, throat and air passages and are spread in droplets of saliva which are sprayed out during coughing, sneezing, spitting or even talking. The germ-laden droplets float about in the air and are breathed in by other persons or they are conveyed on feeding utensils such as cups, glasses, forks and spoons in the saliva and, unless such utensils are sterilized, they will infect persons using them.

Preventive measures against this group of diseases consist of the prevention of overcrowding, good ventilation, the sterilization of feeding utensils and the prohibition of spitting.

Cerebro-spinal fever

The disease is caused by a germ known as a *meningococcus*, which lives at the back of the nose and throat. The germs are to be found in a definite small percentage of the general population and only give rise to the disease in susceptible persons. Healthy carriers constitute a danger and, when their number approaches 20 per cent. in any unit, there is danger of clinical cases of the disease occurring. Unfortunately the discovery of carriers is very difficult without repeated daily bacteriological examination, which is a prolonged process. When discovered, carriers should be isolated and treated until free from infection.

Cerebro-spinal fever is more liable to occur when there are conditions of overcrowding and bad ventilation, as is shown by the seasonal incidence of the disease, for it is more common at the time of year when overcrowding and defective ventilation are greatest, namely during the cold damp months in spring in temperate climates and during the " cold " weather

in hot climates. At these seasons indoor heat is raised by fires, ventilation is apt to be neglected and there is greater risk of droplet infection, as colds and other catarrhal affections are more prevalent.

The most important measures for combating cerebro-spinal fever are the prevention of overcrowding and the provision of an ample supply of fresh air. It is most important that there should be adequate spacing of beds with a full six feet of wall space for each bed, but, where this is impracticable, screens should be erected midway between the heads of the adjoining beds, or alternate beds may be reversed. Any overcrowding usually leads to an increase in the number of carriers.

Overcrowding must also be prevented in dining-rooms, institutes and other places where men congregate; crowded places of public entertainment should be avoided.

The germs of cerebro-spinal fever die rapidly in fresh air, and free ventilation with cool moving air is therefore most important; in cold weather, windows should not be closed but, if necessary, men should be provided with extra blankets.

Men must be taught to place a handkerchief in front of their mouths and noses when coughing and sneezing, in order to protect their comrades from infection. The objectionable habit of spitting must be strictly prohibited.

Other preventive measures consist of the sterilization of feeding utensils, the isolation of cases and carriers, the segregation of contacts until they are proved by bacteriological examination to be free from infection, and the inhalation of steam impregnated with 2 per cent. zinc sulphate.

Diphtheria

The germs of diphtheria inhabit the throat and nose, where they produce a local inflammation and a membrane is formed; they also produce a general poisoning, which may cause paralysis of muscles, especially those of the throat and heart.

The disease is spread by droplet infection and by direct contact, as in kissing, also by indirect contact, as in sucking pencils or using drinking utensils which have been infected by others.

Carriers are common and may be a source of trouble for long periods, but in many of them the germs are not virulent. Susceptibility to the disease can be determined by means of the Schick test, and all those who are found to be susceptible, especially children and recruits, should be rendered immune by means of inoculation.

Preventive measures are the same as for other droplet infections and consist of the prevention of overcrowding, attention to ventilation, and the sterilization of feeding utensils.

Throat swabs should be taken from contacts of cases, and persons found to be harbouring virulent diphtheria germs should be isolated in hospital; those with non-virulent germs need not be isolated.

Influenza

Influenza, as well as the common cold, occurs in epidemics during the winter months and may constitute a serious problem by making large numbers of men ineffective. The duration of an attack is about a week, but lung and other complications may become serious, especially in confined areas as on board ship.

Influenza is caused by a very small filtrable germ or virus and no vaccine has yet been devised which will prevent the disease. A vaccine is frequently used, however, with good results as an inoculation for the prevention of complications which are due to other germs, and the best results are obtained when the inoculation is given in three doses a month before the disease appears.

Special preventive measures should include the avoidance of crowded places such as cinemas, theatres and public meetings, and the sterilization of eating and drinking utensils. Fresh air is the best preventive against influenza, so that every effort must be made to prevent overcrowding and to provide free ventilation. Spraying rooms with formalin is effective. Gargling with permanganate of potash solution (1 part in 5,000) or salt solution (0·8 per cent.) is a useful preventative measure, but it must be done thoroughly, otherwise the solution does not reach the parts of the air passages where the germs lurk. Gargling sometimes tends to induce coughing and spitting and thereby may help to spread the germs rather than otherwise.

Attendants on influenza cases should wear masks to protect themselves.

Small-pox

Small-pox is now a rare disease in the Army, as a result of compulsory vaccination or re-vaccination on joining. The disease in severe form is rarely seen in Great Britain now, although the actual number of cases of small-pox has increased greatly since the compulsory vaccination of infants was discontinued. It is still prevalent, however, in the severe form in both the Near and Far East and in this form may cause great disfiguration and death.

Vaccination in infancy does not protect an individual throughout the rest of his life, and re-vaccination should be carried out at from 12 to 16 years of age. Re-vaccination is always advisable when a person has been exposed to infection

or is going abroad to a country where the disease is prevalent, unless it has been performed successfully within the past two years. Re-vaccination is advisable every five years for persons living in a country where the disease is prevalent. On the occurrence of an epidemic of small-pox it should be done if there is not sufficient evidence of vaccination or re-vaccination within two years.

Tuberculosis

Tuberculosis of the lungs, generally called " consumption," is the disease of all others which results from overcrowding, bad ventilation, lack of sunlight and droplet infection.

A man suffering from tuberculosis of the lungs may, without being aware of it, be spraying large numbers of the germs into the air every time he coughs or spits. The tubercle bacillus, as the germ is called, may live for a long time in the dust of a room. The breathing in of the germs constitutes the most common route of infection in adults. Cows suffer extensively from tuberculosis and, while infected milk probably plays little part in spreading the disease among adults, it is an important means of infection in children, and married soldiers should realize the necessity of a safe milk supply for young families.

Tubercle bacilli attack various parts of the body but more commonly the lungs in adults and the bowels, bones and brain coverings in children ; the onset is insidious and the disease usually runs a prolonged course.

At the present day tuberculosis occurs much less frequently among soldiers than among civilians of corresponding ages, and this is largely due to the attention to bed spacing and ventilation in barracks and the prompt isolation of patients.

Preventive measures consist of ventilation, the prevention of overcrowding, the prohibition of spitting and attention to the cleanliness of rooms.

Particular attention must be paid to offices and store rooms, where men are employed in sedentary occupations in what are often unsatisfactory conditions of lighting and ventilation.

Zymotic diseases

Zymotic diseases are those which are commonly known as the infectious diseases, such as scarlet fever, measles, mumps and whooping cough. They occur more commonly among children, but adults may be affected.

One attack of any of these diseases usually confers immunity against a second attack.

They are all spread by droplet infection and they are particularly infective during their early stages. Further particulars regarding these diseases are given in Appendix 3.

Group 3. Diseases transmitted by animals

The majority of these diseases are conveyed to human beings by the bites of insects.

Insect-borne diseases are each transmitted by a particular kind of insect and in many the infecting agent is a parasite which has to undergo part of its development in the insect before it can infect human beings. The best example is the malaria parasite, which has a definite life cycle in an anopheline mosquito.

The prevention of this group of diseases necessitates, therefore, a study of the life history of the animal vector as well as that of the parasite.

Anthrax

The anthrax bacillus is a spore-bearing germ, which is very resistant to all forms of disinfection. Infection is carried by hides, skins, wool, hair or bristles, and soldiers may contract the disease from the use of shaving brushes or tooth brushes bought from unreliable sources and containing spores which penetrate cuts or abrasions in the skin or lining membrane of the mouth.

The incidence of anthrax has been greatly reduced by strict regulations for the disinfection of bristles and hair. The use of cheap shaving brushes and tooth brushes of foreign origin should be prohibited and all new brushes should be disinfected before being taken into use. (*See* Appendix 16.) The disinfection of brushes and other apparatus used in barbers' shops must be closely supervised. Animals dying of anthrax should never be bled or have their bodies cut open ; they should be buried intact and completely in quick lime, and all ground fouled by the discharges of infected animals or their carcasses must be thoroughly disinfected, preferably by fire.

Dengue fever

Dengue fever occurs chiefly in seaport towns and low-lying coastal areas in tropical and sub-tropical countries, as these are the places inhabited by the culicine mosquito.

The female *Ædes* (*Stegomyia*) *ægypti*, which is the usual vector of this disease, is a beautiful black and silver mosquito, which feeds by day and breeds freely in domestic water supplies and small collections of water in and around houses.

The onset of the disease is usually very sudden with high fever, headache, and pain in the bones, joints and eye muscles. In the later stages, a rash may break out, especially on the wrists and ankles, and there may be itching in the palms of the hands and soles of the feet followed by peeling of the skin. Dengue fever usually occurs in epidemics in the autumn

and a large proportion of men in a unit may become sick from this cause at one time. It is rarely fatal, but convalescence is slow and is characterized by mental irritability or depression.

Prevention consists in anti-mosquito measures and special attention to the destruction of domestic breeding places.

Cysticercosis

This disease is due to infestation by the cysticercus or bladder-worm stage of the tapeworm *Tænia solium.*

Human cysticercosis has come into prominence lately by the discovery that many cases of epilepsy in the soldier are due to this cause.

Infestation of man by the adult tapeworm is due to eating infected pork in which the process of cooking has been insufficient to kill the encysted larvæ.

The cysticercus stage of *T. solium* normally develops in the pig, but occasionally man becomes the intermediate host through accidentally swallowing tapeworm eggs. This may take place by auto-infection in the host from an adult *T. solium* which he is harbouring in his intestine, but more commonly through the contamination of food by tapeworm eggs. The embryos developing from the ingested eggs may invade the brain and cause a variety of nervous manifestations, of which the commonest is epilepsy.

Cysticercosis may be prevented by the careful treatment of known hosts of adult *T. solium* ; by ensuring that pork supplied to the troops is free from cysticercus, thus preventing intestinal infection with the worm ; by avoiding articles of diet specially liable to direct fæcal contamination ; and by the general protection of food. Tapeworm eggs may be spread in the same ways as the infecting cysts in amœbic dysentery, and similar precautions are necessary to guard against the contamination of food.

Guinea worm

Dracontiasis, as guinea worm disease is called, is due to a species of worm, the female of which may be 3 feet or more in length. Both the male and female worm live in the human abdomen and the female, when pregnant, bores her way down into the legs or lower part of the body, apparently in search of water, and comes to lie beneath the skin, where she can often be seen. A small blister forms on the skin and through it is discharged a clear milky fluid, which contains young coiled-up worms. These young worms get into pools and wells and undergo a cycle of development in a species of fresh-water crustacean which, when swallowed in drinking water, liberates the worms and enables them to continue their life in their human host.

There may be some pain and fever and even vomiting or diarrhœa, but usually the only symptoms of guinea worm disease are a feeling of weight in the affected leg and discomfort from the blister.

Guinea worm disease occurs in parts of Africa and India, and African and Indian troops are liable to become infected, although cases may occur also among British troops.

Preventive measures consist of the protection of water supplies from pollution by infected persons and the destruction or removal of infected crustaceans from the water. The former can be attained by not allowing infected persons to go near any water supply, while the crustaceans can be removed by straining the water through fine muslin, or they can be destroyed by boiling the water or at any rate heating it to 65° C.

Infectious jaundice

This disease occurred among troops in the trenches in Gallipoli, France and elsewhere during the Great War and cases have occurred in barracks. It is caused by a spiral-shaped germ called a spirochæte and is transmitted by rats. The blood, urine and bloody sputum of patients contain the spirochætes.

Preventive measures include the destruction of rats and the prevention of their access to food, attention to water supplies and general sanitation, and the disinfection of discharges from patients suffering from the disease.

Malaria

Infection is by the malaria parasite, which has two distinct cycles of development, one in human blood and the other in the female anopheline mosquito.

Human cycle.—When an infected female anopheline mosquito bites a man, the parasites are injected into the blood and get into the red blood corpuscles, where they grow and produce immense numbers of young parasites; these burst their way out of the blood cells in which they have developed and attack other blood cells. The attacks of fever and ague which are characteristic of the disease occur at the time when the young parasites escape from the blood cells. Some of the parasites develop into male and female forms.

Mosquito cycle.—When a female anopheline mosquito bites a person whose blood contains malaria parasites, the blood containing the male and female sexual forms of parasites, as well as the asexual forms, is sucked into her stomach. The female sexual form (gametocyte), after being fertilized by the male gametocyte, undergoes various changes, which result

eventually in the production of vast numbers of young parasites, which find their way into the salivary glands of the mosquito. This cycle takes about ten days and the mosquito is then capable of infecting human beings and remains infective for at least four months. When the mosquito bites someone, the parasites from her salivary glands are injected into the person's blood and go through the cycle of development in the red blood corpuscles as described above.

There are three species of human malaria parasites, namely, *Plasmodium vivax*, which causes benign tertian malaria; *Plasmodium malariæ*, which causes quartan malaria; and *Plasmodium falciparum*, which causes malignant tertian malaria. The three forms of malaria derive their names from the time of development of their respective parasites in the blood and the consequent attacks of fever. In quartan malaria the cycle takes 72 hours and fever occurs on the fourth day. In benign tertian malaria the cycle takes 48 hours and fever occurs on the third day; the same should occur in malignant tertian malaria, but in this variety very often the fever is irregular.

A healthy man may be able to resist the attack of the malaria parasites, but, when his vitality is lowered and the number of parasites in his blood, or their virulence, increases, he develops the symptoms of the disease. Other factors, such as the season of the year in which infection occurs, also affect the time of onset of the symptoms. The period of incubation is therefore very variable, and, while it is usually between 8 and 28 days, it may extend to several months.

The disease usually starts with a cold stage, in which the person looks and feels cold and shivers—this cold shivering stage gives to the disease the name of ague, by which it has long been known. After the cold stage, which lasts about an hour, there is a hot stage of fever lasting four or five hours, and finally a sweating stage with profuse perspiration, a feeling of relief and temporary recovery.

Relapses are of frequent occurrence, especially in benign tertian malaria, and the chronic infection becomes apparent from the wasting, pallor, loss of energy and enlargement of the spleen which result.

Malaria produces an enormous amount of sickness and inefficiency throughout the world, and is one of the chief causes of admission to hospital in the Army in overseas stations in peace. In war it may become the outstanding disease in any area where climatic conditions are suitable, and may become of such importance that it may overshadow all other considerations in the success or failure of a campaign, as it did with the Salonika Force during the Great War.

Preventive measures have been dealt with in Chapter X and include protection against mosquito bites, the destruction of adult mosquitoes, and the prevention of mosquito breeding.

Plague

There are two main types of the disease, namely bubonic plague, which is spread from rats by fleas and is characterized by glandular swellings, and pneumonic plague, which is a disease of the lungs and is spread by droplet infection.

Plague is a disease of rats, but squirrels and many other rodents may be sources of infection; during epidemics, domestic animals may suffer from pneumonic plague and transmit infection.

The bubonic form of the disease is the more common and, as already stated, is conveyed from rat to man by the rat flea. It occurs in epidemics among rats causing many deaths. Infected fleas leave the dead rats and attack the nearest human beings. The discovery of dead rats or squirrels near buildings, especially in the tropics, should always be regarded as a danger sign that plague may be present.

Plague is endemic in India, China and Africa, where epidemics are of common occurrence, although isolated cases may occur anywhere, particularly near docks, or among persons coming in contact with natives of the above named countries. The spread of the disease tends to be along trade routes, and the pneumonic form appears on those routes through the colder parts of Asia. The Manchurian marmot, in which the plague bacillus exists as an intestinal infection, acts as a reservoir of the infection from which great epidemics have spread; camels and donkeys may also be the means of spreading pneumonic plague.

Preventive measures.—As bubonic plague is spread chiefly by rats and fleas, measures must therefore be concentrated against the destruction of these pests as described in Chapter X. Cases of plague and their contacts must be isolated, cleansed and disinfested; persons employed in disinfestation and rat destruction and attendants on patients must be protected from flea bites by suitable clothing. Dead rats should be destroyed and should never be handled with naked hands. Quarantine barriers should be raised and strict control kept over all persons entering military areas, quarantine camps being established if necessary.

Inoculation against plague is apt to be painful with a marked reaction lasting often for 48 hours; this necessitates careful consideration as to what personnel should be inoculated. It is not as a rule necessary to carry out the wholesale inoculation of troops, except in face of a severe epidemic, but it is advisable to afford this means of protection to sanitary and

medical personnel and those engaged in the destruction of rats.

The occurrence of cases of pneumonic plague necessitates special attention to ventilation, the prevention of overcrowding and the use of face masks by patients and those attending them, in order to prevent the spread of infection by droplet infection. The risk of infection by pneumonic plague from domestic animals must not be forgotten.

Rabies (hydrophobia)

Rabies is a disease which affects dogs, cats, jackals, camels, horses, cattle and sheep. The virus is contained in the saliva and human beings usually contract the disease from the bites or licks of infected dogs. The saliva of the infected animal may be infective for five days before symptoms appear, and the rabid animal usually dies within five days after the onset of symptoms; observation, therefore, of the suspected animal for a period of ten days will decide whether it was rabid at the time of biting or licking.

The incubation period varies from three weeks in the case of severe bites on the face to eight or even twelve months where abrasions of the skin of the hands or feet have only been licked. This allows time in most cases for preventive treatment, which consists of a course of inoculations.

Preventive measures.—In hot countries, where rabies is prevalent, all dogs should be licensed and carry the name and address of the owner; stray and ownerless dogs and diseased jackals should be destroyed. An animal suspected of rabies should on no account be destroyed until it has been observed and pronounced rabid by a competent person. The brain of the dead or killed animal should be sent to a laboratory for examination and its handling, removal and despatch must be carried out by competent persons. Bites should be cauterized with pure carbolic acid or similar disinfectant without delay, and a person who has been bitten or licked by an animal proved to be rabid should undergo a course of anti-rabic treatment.

Muzzling orders and orders as to chaining up and keeping dogs on a leash, also quarantine regulations for dogs, should be made, if necessary, and all cases of rabies amongst animals must be notified.

Relapsing fever

Many diseases are characterized by relapsing fever, wherein the temperature, after being high for some days, returns to normal for a shorter or longer period and then rises again, followed by further alternate falls and rises. The true relapsing fever, however, is a disease caused by one of the spiral-shaped

higher forms of germs, called a *Treponema*, which is transmitted by lice, ticks and possibly by bed bugs.

The louse-borne type of the disease occurs in North Africa, India and some parts of Europe, and has been a common cause of sickness among native labour corps in Egypt, Palestine and Mesopotamia. A special type of the disease, conveyed by ticks, is found in Central and East Africa.

Preventive measures must be directed against lice and other vermin. Native villages, huts and bedsteads should be avoided.

Sandfly fever

Phlebotomus fever, which is its correct name, is very widely spread and occurs in a great many foreign stations. The infecting agent has not been identified yet but is probably a filtrable virus and is transmitted by the bite of the female *Phlebotomus*, commonly called the sandfly.

An attack of the disease is usually short and sharp with sudden onset of fever, headache, pains all over the body and intense discomfort for about 3 days. Convalescence, as after dengue fever, may be prolonged and accompanied by mental irritability or depression.

Female sandflies usually feed at dusk and dawn, biting all exposed skin surfaces and through light clothing. The bites are painful, producing intense irritation and even an eruption resembling chicken-pox. The blood of a patient is only infective during the first 24 hours of the disease, and the female sandfly becomes infective after 6 days and remains so for the rest of her life.

Preventive measures have been detailed in Chapter X. Sandfly nets should be used for patients in the early stages of the disease at least. On active service the issue of the bivouac pattern of sandfly nets to the troops is often essential and, although these nets may cause discomfort from heat, the men prefer this to the intense irritation and loss of sleep caused by the bites of the sandfly. When nets cannot be used, reliance has to be placed on repellants applied to exposed parts and to the ankles under the socks, if trousers are worn.

Trench fever

This disease is transmitted by lice; the causal germ apparently multiplies in the intestine of the louse and is passed out in the fæces, which may remain infective for a long time. Infection is caused by the fæces of infected lice being rubbed into scratches or other skin abrasions; the bite of the louse does not seem to produce trench fever, but this is not yet definitely proved.

The onset of the disease is characterized by fever and pain

in the limbs, and a dull gnawing pain in the shins (shin pains) is typical. It is not a fatal disease, but may affect large numbers of men at one time so that the effect on fighting efficiency may be most serious.

Prevention consists in louse prevention as in typhus fever. The urine and sputum of patients contain the virus and must therefore be disinfected.

Typhus fever

The germ which causes typhus fever has not yet been identified, but it is conveyed by lice, either by their bites or by their fæces being rubbed into scratches or other abrasions in the skin.

Typhus fever has been one of the most destructive diseases of armies in the past, but, as the difference between it and typhoid fever was only discovered sixty years ago, much of the mortality that was ascribed to it may have been due to typhoid fever. It has been called jail, famine and hospital fever. It occurs among the very poor and in crowded and dirty populations, especially in south-eastern Europe, but improved sanitation has practically stamped it out in modern towns. During the Great War in Serbia in 1915 the population was decimated at the rate of 500 a day, while in Russia epidemics of the disease have caused an enormously high mortality. It is liable to attack troops in a besieged garrison or wherever surroundings are insanitary and quarters overcrowded.

The most important means of preventing typhus fever is the regular disinfestation of men and their clothing, bedding and equipment and the destruction of lice, as described in Chapter X. Other preventive measures are the prevention of overcrowding and attention to cleanliness of the person and dwellings.

Tropical Typhus

This name is used for a group of diseases, resembling typhus fever, which are widely spread and show many local variations, for example, Rocky Mountain spotted fever and the typhus-like diseases found in Mexico, Malaya, North and South Africa, India and Australia.

There is no evidence that the infection is transmitted by the louse; some varieties are known to be conveyed by ticks and others by mites. Famine, poverty and overcrowding are not specially associated with the disease. The majority of cases resemble mild cases of typhus fever.

Undulant fever

Formerly known as Malta or Mediterranean fever, this disease occurs principally in Mediterranean coastal areas,

although it is found also in Africa, India, China and the West Indies. A form of the disease, due to the germ causing contagious abortion in cattle, has recently been found to occur in the United Kingdom and in many parts of Europe, America and elsewhere.

Undulant fever is a disease which is prevalent among goats and is caused by a minute germ, called a *micrococcus*, which is conveyed to man in goat's milk, although it may also penetrate the unbroken skin. The germs pass out of the body in the excreta, particularly in the urine and fæces.

Germs which cause contagious abortion in pigs and cattle may cause a form of undulant fever in man, indistinguishable from that transmitted from goats, except that cases are usually milder.

The disease shows itself by successive attacks of continuous fever, each attack lasting two or three weeks; during the periods between the fever there is neuralgia, with pains in the joints resembling rheumatism. The duration of the disease is very prolonged; one attack will give immunity from further attacks.

The chief measure of prevention is the avoidance of goats' milk and its products—butter, cream and cheese—and the pasteurization of cows' milk, where cows are known to be infected. Infected goats should be destroyed.

The excreta of patients and soiled articles of clothing and bedding must be disinfected and special attention paid to personal cleanliness.

Yellow fever

The infecting agent of yellow fever is a virus which is transmitted by the bite of the female culicine mosquito, *Ædes* (*Stegomyia*) *ægypti*, which also conveys dengue fever. The virus disappears from a patient's blood after the fourth day of the disease, and the mosquito is not infective until about twelve days after feeding, but then remains infective for the rest of her life. The disease derives its name from the jaundice which occurs in the later stages.

Yellow fever originated in West Africa and was imported by slave ships into America and the West Indies. From these localities widespread epidemics have spread to Europe, but owing to rigid quarantine regulations its range is now restricted to certain parts of Africa, Central and South America.

The incubation period of yellow fever is usually 3 to 5 days, but may be as much as 14 days. Control of the disease was simplified when journeys between continents were slow and the disease, if present, manifested itself during the journey, but with modern rapid means of transport, especially by air,

there is a grave risk of the spread of yellow fever to countries where it has not existed previously.

Preventive measures must include all anti-mosquito measures, especially in and near dwellings, and rigorous quarantine regulations. The prevention of its spread from country to country by air transport is specially dealt with in the International Sanitary Convention for Aerial Navigation, 1933.

Group 4. Diseases transmitted by direct personal contact

Direct contact with an infected person or his belongings is a route of infection in many diseases, but the diseases included in this group are those which are usually transmitted by direct personal contact with the body of an infected person.

Scabies

Scabies is due to the burrowing into the skin of the Itch Mite, as described in Chapter X. Although a minor complaint, this disease may cause a considerable amount of inefficiency on account of loss of sleep from the irritation and skin infections from scratching. It might equally well be included in the group of diseases conveyed by animals, but it is included in this group, because it is spread by close contact and so is closely allied to venereal disease ; infection may also be spread by infected bedding and clothing. The wrists and webs of the fingers are usually affected, but it is also found on the genitals.

Scabies can be cured easily and quickly if treated early, and much can be done to reduce the incidence by regular skin inspection and the prompt isolation and treatment of infected men, with complete disinfection of all their kit.

While there has been a steady decrease in venereal disease in the Army there has not been any great decrease in scabies. This is probably due to the attention paid to venereal disease and the education of the soldier in methods of prevention ; the same should be done in the case of scabies. It is frequently found that men returning from leave are suffering from scabies and it is therefore desirable that all men rejoining their units should be inspected before returning to their barrack rooms, and, if considered necessary by the medical officer, the clothes which they are wearing should be disinfested.

Skin diseases

Many skin diseases are spread by close contact, although they are more often conveyed by infected clothing or toilet articles.

Ringworm.—Under this heading is included a number of infections of the skin by various forms of fungi. These fungi spread irregularly over the skin and also to different parts of the body by contact with infected parts.

Dhobie itch.—In its typical form it appears as a reddish brown patch on each side of the crutch and armpits and it is very irritating. The disease is due to a fungus, which is transmitted by contact and also, as its name applies, by means of native laundries. The itching is worst at night and in warm weather, but in cold weather the condition subsides and the affected skin becomes dry, brown and scaly, although the infecting fungus is still present and ready to become active again on the return of warmth.

Impetigo (Barber's rash).—This disease is a germ infection of the skin, usually of the face, appearing as raised sores, which discharge and are very infective. Infection may be by direct contact but is usually from infected toilet articles such as towels, razors and shaving brushes.

All these skin diseases can be prevented by personal cleanliness, cleanliness of toilet articles and by satisfactory laundry arrangements. Barbers' shops must be supervised and razors, scissors and other apparatus disinfected after use. In foreign stations native washermen, known as dhobies in India, must be supervised to ensure their cleanliness and that their laundering and storage of clothing is carried out satisfactorily.

Venereal diseases

There are three forms of venereal disease, namely, syphilis, gonorrhœa and soft sore, and in each case the germs are usually conveyed from one person to another during sexual intercourse. Infection by other forms of direct contact, such as kissing in the case of syphilis, are possible but comparatively rare; the great majority of men are infected by illicit sexual intercourse with diseased women, and the emphatic denials of such intercourse may usually be regarded as falsehoods.

Syphilis is a constitutional disease, which, unless it is inherited from the parents, gains access to the system through some small abrasion, usually, but not always, on the external genital organs.

The disease is characterized by three stages, which are not clearly separated from one another.

The first stage is marked by the presence of a sore or ulcer on some part of the body—penis, lip, tongue, etc.—which has been exposed to infection. It is important to remember that the syphilitic sore is very often quite painless.

The second stage, when the whole constitution is involved,

may be, but is not necessarily, marked by painless ulcers in the throat, various skin rashes which do not itch, and loss of hair. More rarely, serious affections of the eyes, ears, lips and tongue may occur. In this, as well as in the primary stage, the discharges from the sores on the genitals and other parts of the body are contagious and may easily convey the disease to other persons, whether by sexual intercourse or through the common use of such articles as towels, feeding utensils and pipes.

The third stage supervenes in the course of months or years if treatment is not carried out efficiently and for a sufficient length of time. It is characterized by ulcers and swellings in various parts of the body, disease of the bones and very grave affections of the brain and spinal cord, such as general paralysis of the insane and locomotor ataxy.

The seriousness of syphilis is increased by the fact that it renders a soldier inefficient for a long time, and also because, if he marries before he is cured, he may give it to his wife, and his children may inherit it. Syphilis in children is more serious than in adults and very often leads to early death, crippling, deafness, blindness or idiocy.

Gonorrhœa is far more common than syphilis and may also be followed by very grave consequences.

It is caused by a germ, which in a very few days sets up a violent inflammation in the urethra (water pipe) causing scalding in passing water and a copious discharge. Swelling of the testicles and consequent sterility, a dangerous affection of the eyes, and a troublesome form of rheumatism may also occur. Following an attack of gonorrhœa, a stricture or narrowing of the urinary passage may take place, which, if neglected, will cause disease of the bladder and kidneys. Chronic infection of the knee and shoulder joints may result from gonorrhœa, and infection of the heart may also occur.

The treatment is difficult and tedious. If it is not begun early and carried out efficiently, patients, though apparently cured, may convey the disease to women, and mothers may infect the eyes of their infants at birth. This is a common cause of blindness.

Gonorrhœa is almost always contracted by sexual intercourse, but the infection may be conveyed to the eyes, even when the discharge has almost disappeared, by means of the hand or by using the towel of a man suffering from the disease. Patients should, therefore, be very careful about washing their hands and seeing that they do not soil latrine seats for fear that healthy people may be infected. Towels, nail and tooth brushes belonging to patients should never be used by others.

Soft sore occurs in the same way and in the same parts of the body as syphilis. The sore tends to become infected with other germs, but yields to treatment and clears up after several weeks.

Prevention of venereal diseases.—Having regard to the usual mode of infection, the only sure preventive measure against venereal diseases is abstention from promiscuous intercourse with women. Manly chastity must be encouraged ; it is a mistaken idea that sexual intercourse is necessary to maintain health.

Venereal diseases are communicable diseases, caused by germs which invade the body, and the ordinary principles of prevention for any communicable disease are applicable.

Measures directed against the source of infection are, however, difficult to apply in practice. The route of infection is direct physical contact, and the protection of the healthy man furnishes, therefore, the best line of defence.

It is most important to remember that after the disease has begun, every day's delay lessens the chances of cure. It is the height of folly to delay seeking the advice of the medical officer or to apply some chemist's or quack's remedy.

A soldier who does these things is not only his own enemy, but the enemy of his comrades, since he may easily convey the disease to them. A soldier who has indulged in illicit sexual intercourse should (whether he has disinfected himself afterwards or not) keep a close watch on his genital organs for a month or six weeks afterwards. If the least itchiness is felt at the end of the pipe, if there is the slightest discharge, if any spot appears, or the foreskin becomes swollen, he should report sick at once.

" A soldier who neglects to report sick without delay, when suffering from venereal disease, is guilty of a military offence." (King's Regulations, 1928, para. 529.)

The provision of facilities for healthful exercise, and amusement, outdoor and indoor, by day and in the evenings is essential, and it is the duty of regimental officers to organize athletic and social recreation for the men under their command.

Group 5. Diseases due to exposure

Such diseases are not due to germs or parasites and are not communicable. They are frequently the result of negligence or ignorance and may cause considerable sick wastage if measures are not adopted for their prevention.

Effects of heat

The production of heat and its dissipation from the body have been explained in Chapter II. When the dissipation of heat from the body cannot keep pace with the amount of heat produced, the heat regulating centre is thrown out of action and a condition of heat-stroke or heat-exhaustion arises. Sunstroke is the term usually applied to heat-stroke due to exposure to the direct rays of the sun.

These conditions and means for preventing them have been described already in Chapter II.

Malaria often closely resembles heat-stroke, and it may be very difficult to distinguish between them. In all doubtful cases the blood should be examined for malarial parasites.

Heat-stroke can be prevented by physical fitness, wearing suitable light and loose clothing, with open necks and bare arms, and avoiding excessive fatigue, constipation, and any form of over-indulgence.

The first signs of impending heat-stroke are the stoppage of sweating, resulting in a hot dry skin, and a repeated desire to pass water. These signs may appear from 1 to 24 hours before the actual onset of heat-stroke and, when they occur, prompt treatment is necessary.

Treatment consists in placing the individual in the shade, removing all clothes, douching the whole body with cold water and fanning it, preferably with an electric fan. In up-to-date hospitals in the tropics, air conditioned wards are provided for the treatment of such cases, but at present there are no such wards in military hospitals.

The atmospheric conditions under which heat-stroke is likely to occur are those showing little or no air movement and a wet-bulb temperature above 83° F. (28·4° C.).

Sunburn

Direct exposure of the skin to the sun's rays may produce actual superficial burns of the unacclimatized skin, and salt water or sweat will increase the intensity of such burns.

Young soldiers, newly arriving in the tropics, should be warned against rash exposure of the skin, which may lead to severe burns. The skin must be acclimatized by gradual exposure to the sun with very short periods of exposure at first.

Sun bathing with the body wet with sea water or sweat should be avoided.

Frost bite

Exposure to intense cold causes slowing and eventual stoppage of the circulation of the blood in exposed parts of the

body, followed by actual freezing of the skin and death of the affected parts. The extremities of the body such as the toes, fingers, ears and nose are the parts most usually affected.

Frost bite is prevented by means of warm clothing covering the extremities, the avoidance of tight boots, gloves, puttees or other articles of clothing and the stimulation of the circulation by active exercise.

If frost bite occurs, the affected part must be thawed gradually by rubbing it with snow or the application of cold water and not by hot water or exposure to a fire.

Trench foot

Trench foot, as its name implies, is usually associated with conditions of stationary warfare and with prolonged and constant soaking of the feet under conditions of inactivity, cold and exposure, combined with interference with the circulation in the legs and feet due to tight puttees and boots.

The condition must be clearly distinguished from frost bite. Cold is merely a contributory factor and moisture, pressure and inactivity all play a part, while age is important in view of the fact that young men are more frequently affected. Dirtiness and lack of attention to the skin of the feet and toes definitely predispose to the onset of trench foot and lead to complications by infection with germs.

Trench foot is a disease in which preventive measures essentially concern company and platoon officers, as it can be practically eliminated by training and discipline.

Preventive measures include cleanliness and the disinfection of the feet; the daily removal of the boots and massage of the feet; frequent changing of socks and dusting them inside with camphorated talc powder before putting them on; the prevention of restriction of circulation by winding puttees loosely and tying bootlaces loosely; the encouragement of activity; short periods of duty in wet trenches; the supply of hot food; general measures for the drainage of trenches and the provision of duck-boards.

Suggested orders for the prevention of trench foot are given in Appendix 17.

Group 6. Diseases due to injury

Tetanus

Men and animals carry the spore-bearing tetanus germs in their intestines and the germs therefore abound in sewage and soil which has been manured.

The disease is contracted by wounds or abrasions being contaminated with earth; war wounds in heavily cultivated countries are especially liable to infection.

All wounds, cuts and abrasions which have been contaminated with earth must be thoroughly cleaned and treated, and the patient should receive an injection of anti-tetanus serum.

Group 7. Diseases due to food

Certain diseases may result from germ infection conveyed by food ; others may be caused by a deficiency of certain essentials in the food, such as vitamins ; of the latter there are two of military importance, namely beri-beri and scurvy.

Beri-beri

The cause of beri-beri is usually considered to be a deficiency of Vitamin B1 in the diet, although some think it to be a communicable disease caused by a germ. It does occur, however, when there is a lack of Vitamin B1 in the diet. This vitamin is contained in a great many fresh foods and especially in yeast and the germ and husk of grains, such as rice and wheat. The disease occurs chiefly in countries where rice forms the main article of the diet and this is largely due to the eating of rice from which the germ and husk, containing Vitamin B1, have been removed by polishing.

One of the earliest symptoms of the disease is a feeling of fullness and discomfort in the stomach ; this is followed by weakness of the legs, numbness of the feet and an inability to rise from the squatting position.

Persons of sedentary habits are more liable to beri-beri than those who lead an active healthy life. Insanitary conditions also favour the onset of the disease.

Beri-beri can be prevented by providing a plentiful supply of fresh foods containing Vitamin B1, such as oatmeal, beans, peas and lentils. When such foods are not available, a quarter of an ounce of the yeast extract called " Marmite " should be given twice a week ; pea flour and the wheat-extract " Bemax " are also useful.

Scurvy

Scurvy is due to a deficiency in the diet of the antiscorbutic Vitamin C, which is chiefly contained in fresh green vegetables and fruits and to a much less extent in fresh meat (*see* Chapter V) ; it may result even when the diet contains sufficient of these items if the vitamin is destroyed by prolonged cooking.

Scurvy is not a communicable disease, but it has been the cause of an immense amount of sickness and of many deaths in armies, and is especially liable to occur amongst beleaguered garrisons and on board ship in conditions under which fresh food supplies cannot be obtained.

In the Crimean War the Turkish army was nearly destroyed, by it, and there were 40,000 cases in the allied English and French armies.

It occurred to some extent during the South African War, more especially in besieged places, but also on the line of march, when preserved rations only were obtainable. It was also very prevalent amongst Asiatic and African troops recently in Somaliland, and was one of the causes that led to the capitulation of Port Arthur in the Russo-Japanese War.

The occurrence of scurvy in a unit in peace time is an indication that the messing arrangements are bad and that officers in charge of messing must increase the supply of fresh food and improve the methods of cooking.

The disease appears at first in the form of pains in the calves of the legs, and later the gums become swollen and tender and marks like bruises appear on the body.

Scurvy can be prevented by the inclusion of fresh meat, green vegetables and fruit in the diet. The citrus fruits, namely, oranges, lemons, and grape fruit are rich in Vitamin C when fresh. Their preserved juices, if well prepared, also contain large amounts of this vitamin and retain an effective supply of it for three months. Limes and the so-called " lime juice," on the other hand contain little or no Vitamin C, and are useless as antiscorbutics. Tomatoes are a valuable source of Vitamin C, as canning does not destroy their vitamin content. Germinated peas, beans or other pulses are a suitable substitute when insufficient fresh food is available (*see* Appendix 9). It is important that these germinated pulses should be cooked and eaten as soon as possible after germination.

Infants fed on boiled milk, condensed or dried milk may develop scurvy, through lack of Vitamin C, and should therefore be given orange juice.

CHAPTER XIII

HYGIENE ORGANIZATION IN THE ARMY

The more important diseases which affect a military population, the measures necessary to combat them and the methods for preservation and promotion of the health of the soldier have been dealt with in previous chapters, and it now remains only to outline the organization through which these measures are put into operation in the Army.

The hygiene organization in the Army provides a complete chain of responsibility from the War Office down to the individual soldier, every link of which is of importance and cannot be dispensed with.

The training of all ranks in hygiene and sanitation is as necessary as is their training in any other branch of military science, and it is only by a knowledge of the hygiene organization of the Army and the scope and importance of sanitary measures that the enthusiasm and interest, which are necessary to maintain a high standard of sanitation, can be aroused.

Organization in peace

The Director General, Army Medical Services (D.G.A.M.S.) is the responsible adviser on all questions affecting the health of the Army. At the War Office, under the D.G.A.M.S., there is a Director of Hygiene and his Assistant Director of Hygiene (A.D.H.), who constitute the Directorate of Hygiene.

Directorate of hygiene

The chief aim of the Directorate is the conservation of the man power of the Army by the promotion of mental and physical health and the prevention of disease.

Other objects of this organization are :—

(*a*) To ensure that the present and future mental and physical health of the troops and their families are supervised closely by officers who are recognized as leaders in hygiene, and that the highest efficiency is attained thereby.

(*b*) To utilize fully all information affecting the health of the troops and to organize research in regard to new methods for promoting health and preventing disease.

(*c*) To co-ordinate the work of various departments and individuals engaged in hygiene research and concerned with problems relating to hygiene.

(*d*) Through the agency of the above, to effect economy in the Army and thereby to the State by improving the efficiency of the soldier and preventing wastage and loss of time in training, on account of disease.

In the achievement of these aims and objects everything which either directly or indirectly affects the health and well-being of the soldier and his family comes within the purview of the Hygiene Directorate.

The matters dealt with by the Directorate are therefore many and varied.

The more important are :—

1. Recommendations in regard to the appointment of the Hygiene Staff at the Royal Army Medical College and Army School of Hygiene and of assistant and deputy assistant directors of hygiene and sanitary personnel in commands and districts at home and abroad, and of the Senior Medical Officer, Recruiting, and of the Embarkation Medical Officer, Southampton.
2. General supervision over the teaching of hygiene and sanitation in the Army.
3. Arrangement of courses of instruction at the Army School of Hygiene, and inspection of the School and hygiene laboratories.
4. Hygiene inspections in commands and districts when necessary.
5. Preparation of the hygiene section of the Annual Report on the Health of the Army.
6. Measures for the maintenance of the health and well-being of the troops and their families.
7. Organization and supervision of maternity and child welfare schemes.
8. Measures for the prevention of disease in the Army, including matters relative to the prevention, diagnosis and treatment of venereal diseases.
9. The medical aspects of recruiting and physical training, including the elimination of unfits on enlistment and the discharge of recruits with less than six months' service, other than by invaliding; questions relating to the physical standards of candidates for commissions and of recruits; also the organization of research in regard to the physiology of physical training and the suitability from the physiological aspect of army methods of physical training.

10. Technical advice on hygiene and sanitary questions in connection with housing and accommodation in barracks, camps and transports; also on water supplies, food, clothing, equipment, training, conservancy and disinfection.
11. Medical and sanitary questions connected with changes in standard plans of buildings for the accommodation of army personnel.
12. Collection of information regarding geology, climate, water supplies, prevailing diseases and other relevant matters likely to affect health in possible theatres of war and formulation of suitable hygiene measures to meet requirements.
13. Representation on committees dealing with army estimates.
14. Consideration of inventions dealing with disease prevention.
15. Liaison with civil public health departments at home and abroad and with the hygiene services of the Royal Navy and Royal Air Force.

The Army Hygiene Advisory Committee

This committee is appointed to advise and assist the medical services of the Army in all important health matters It has the Director of Hygiene as President and his Assistant Director at the War Office as Secretary; the members consist of the Professor of Hygiene, R.A.M. College, the Commandant of the Army School of Hygiene, representatives from various departments of the War Office, a medical officer from the Ministry of Health, and two distinguished civilians, one a hygienist and one a physiologist.

Royal Army Medical College

The Hygiene Department has a Professor, an assistant professor, a chemical analyst and a staff of trained sanitary personnel and laboratory assistants.

The department carries out the general hygiene training of medical officers, the special training of specialists in hygiene and of sanitary assistants and laboratory attendants. It also undertakes various investigations and research work, and in the laboratory the chemical analyst carries out all examinations and analyses of water supplies, food, disinfectants, etc., for the Army at home, exclusive of Aldershot.

Army School of Hygiene

Here the sanitary training of officers and other ranks of the combatant branches of the Regular and Territorial Armies is carried out, courses of instruction being held in water duties,

hygiene and sanitation. Here also junior officers of the R.A.M.C. and I.M.S. receive training in practical field sanitation, and special classes are held for the training of sanitary assistants of the R.A.M.C., Field Hygiene Sections, and Medical Units of the O.T.C.

Research work in practical sanitation is also undertaken, and in the chemical laboratory of the school examinations and analyses of water supplies, food, etc., for the Aldershot Command are carried out.

Hygiene organization in commands, districts and areas

Assistant Directors of Hygiene (A.Ds.H.) are attached to the staffs of commands at home and abroad ; they act as technical advisers to the deputy directors of medical services (D.Ds.M.S.) and under them are responsible for dealing with all problems in their command relating to hygiene and the medical aspects of recruiting and physical training. They also maintain touch with the Directorate of Hygiene at the War Office and liaison with the civilian medical officers of health in the areas comprised within the commands.

Deputy assistant directors of hygiene (D.A.Ds.H.) are allotted to districts or areas and advise their assistant directors of medical services (A.Ds.M.S.) on technical matters, their duties in the districts or areas corresponding to those of the A.Ds.H. They, in turn, maintain touch with the A.D.H. of the command and liaison with the local medical officers of Health.

A.Ds.H. and D.A.Ds.H. have a definite establishment of trained sanitary assistants to assist them in inspection, disinfection and clerical duties.

The officer in medical charge of a unit acts as technical adviser to the commanding officer in matters connected with health and makes such recommendations as he may consider necessary for the maintenance and promotion of the health of the troops and the prevention of disease. He makes sanitary inspections of all parts of barracks and married quarters at least once a month and records the sanitary defects found, and the recommendations made verbally to the commanding officer, in a sanitary diary, which is passed to the officer concerned.

Each unit has a definite establishment of specially trained sanitary personnel to carry out executive duties in connection with conservancy and to act as sanitary police ; their duties are allotted by the commanding officer in consultation with the officer in medical charge of his unit.

When large concentrations of troops occur for training camps or manœuvres, unit sanitary organizations are supplemented by specially trained R.A.M.C. personnel, mobilized in field

hygiene sections, to carry out special technical duties in connection with water supplies, the protection of food from contamination, conservancy and disinfection.

Army School of Physical Training

A hygiene specialist, graded as a D.A.D.H., is on the staff of this school and his duties comprise (*a*) the supervision of physical training from the medical aspect, (*b*) instruction in anatomy, elementary physiology, first aid and remedial exercises to those being trained as physical training instructors, (*c*) research in regard to the physiology and other aspects of physical training, and (*d*) medical charge of the school.

All officers of the R.A.M.C. undergo a course of instruction at this school on entering the service, to ensure that they understand the army methods of physical training, its aims and objects and the medical aspects of the training. Hygiene specialists also receive special instruction at the school.

Central London Recruiting Depot

There are 4 medical officers at this depot and the senior is graded Senior Medical Officer, Recruiting, for the whole Army and, under the Director of Hygiene, supervises and co-ordinates the medical aspects of recruiting throughout the Army and scrutinizes and criticizes A.Fs. B 215A and B 204, which deal respectively with the Monthly Return of Recruits discharged Medically Unfit and Applications for Discharge of recruits under six months' service, on medical grounds.

He also assists the Hygiene Directorate in the preparation of Statistics in connection with recruiting.

Hygiene specialists receive special instruction in the medical aspects of recruiting at this depot, and all officers of the R.A.M.C. also receive instruction here on joining the Service.

Organization in war.

The hygiene organization on active service is an elaboration of that in the Army under peace conditions. The personnel employed on sanitary duties have, however, to be greatly increased by the provision of specially trained and equipped units, since under war conditions troops move rapidly from place to place and camps and billets have to be chosen with a view to military necessity rather than to healthy surroundings.

The D.G.A.M.S. is represented at general headquarters of a force by a director of medical services (D.M.S.), who is responsible to the commander-in-chief of the force for the organization and administration of all health measures. In lesser formations and areas the D.M.S. is represented by D.Ds.M.S. and A.Ds.M.S., who are responsible to the com-

occupied by the force, (*b*) the solution of sanitary problems, and (*c*) to arrange for the provision of supplies of sanitary appliances and materials for the force.

A variety of special units, concerned directly or indirectly with the health of the troops, may be mobilized according to the requirements of a campaign, and among the most important are units for the purification and distribution of drinking water and cleansing units for the establishment of laundry, bathing and disinfecting centres.

It will be seen from the outline given in this chapter that the hygiene organization of the Army in peace and in war provides a chain of specially trained personnel which links up the smallest unit to the highest.

The responsibilities of the medical services in regard to sanitation are chiefly advisory and supervisory, but the responsibility for the actual performance of sanitary work and the observance of sanitary orders rests not only with commanding officers, but also with every officer, warrant officer, N.C.O. and man throughout the Army.

APPENDIX 1

COMPARISON OF BATTLE AND NON-BATTLE CASUALTIES AMONG BRITISH TROOPS IN WAR.

Campaign	Duration	Average strength	Non-battle admissions to hospital	Casualties, deaths in hospital	Battle casualties		Approximate average annual ratio per 1,000 of strength			
							Non-battle casualties		Battle casualties	
					Admissions to hospital	Killed in action and died of wounds	Admissions to hospital	Deaths in hospital	Admissions to hospital	Killed in action and died of wounds
Crimean War	1854–6	111,000	—	21,000	—	4,058	—	89	—	17
Zulu War ..	1879	12,651	9,348	314	162	800	988	33	17	85
Afghanistan ..	1878–80	10,246	28,761	1,122	Including non-battle	161	1,443	56	—	8
Egypt ..	1882	13,013	7,212	79	378	93	2,380	26	125	31
Nile Exped. Force ..	1884–5	10,771	8,712	431	241	126	589	29	16	8
Chitral Relief Force ..	1895	5,213	3,935	128	35	13	1,531	50	14	5
N.W. Frontier, India ..	1897–8	5,741	11,065	291	416	149	2,393	63	90	32
S. Africa ..	1899–1902	208,226	404,126	14.048	21,292	7,091	728	25	38	13
Great War										
France and Flanders ..	Aug. 1914 to 1918	1,235,644	3,528,486	32,098	1,988,969	532,617	647	6	364	98
Macedonia ..	Oct. 1915 to 1918	123,903	481,262	3,744	18,187	4,096	1,195	9	43	10
Egypt and Palestine ..	1915–1918	169,925	503,377	5,981	40,186	10,387	741	9	59	15
Mesopotamia	Nov. 1914 to 1918	61,614	298,774	4,775	22,736	7,409	1,164	19	89	29
East Africa ..	Sept. 1914 to 1918*	49,983	336,540	6,308	7,728	2,794	2,244	42	52	19
South-West Africa ..	Aug. 1914–Jul. 1915	33,000	24,746	181	621	246	750	5	19	7
North Russia	Aug. 1918 to 1919	10,547	9,582	121	529	211	681	9	39	15
Italy	Nov. 1917 to 1918	94,634	51,311	759	4,747	1,288	465	7	43	12
Dardanelles ..	Apr. 1915–Jan. 1916	117,068	145,154	2,108	47,803	16,580	1,756	25	574	200

* Figures relate to years 1916 to 1918 only.

Army Hygiene Organization in Peace

War Office

- *Hygiene Directorate*
  Director of Hygiene
  Asst. Director of Hygiene
  - *Central London Recruiting Depot*
    S.M.O., Recruiting
  - *Army school of Physical Training*
    Hygiene Specialist
  - *R.A.M. College Hygiene Dept.*
    Professor of Hygiene
    Asst. Prof. of Hygiene
    Analytical Chemist
    Sanitary Assistants
    Laboratory Attendants
  - *Army School of Hygiene*
    Commandant and Chief Instructor
    Instructor
    Officer i/c Chemical Laboratory
    ,, ,, Bacteriological Laboratory
    Quartermaster and Instructor
    and a Staff of N.C.Os. and men
  - *Commands*
    A.D.H.
    Sanitary Assistants
    - *Districts and Areas*
      D.A.D.H.
      Sanitary Assistants
      - Officers in medical charge of units
- *Army Hygiene Advisory Committee*
  President—Director of Hygiene
  Secretary—A.D.H., War Office

  Members :—
  Professor of Hygiene, R.A.M. College
  Commandant, Army School of Hygiene
  Representative from A.M.D.2, War Office (statistics)
  ,, S.D.4, War Office (training)
  ,, Q.M.G.1, War Office (quarters)
  ,, D.W., War Office (works)
  ,, M.O., Ministry of Health
  Civilian Hygienist
  Civilian Physiologist

Army Hygiene Organization in War

G.H.Q.
A.D.H.
Mobile Hygiene Laboratory

- *Corps*
  D.A.D.H.
  Field Hygiene Section
  - *Divisions*
    D.A.D.M.S.
    Divisional Field Hygiene Section
    - *Units*
      Regimental medical officer
      Water duty personnel
      Sanitary personnel
- *Base Sub Area*
  D.A.D.H.
  Field Hygiene Section
  - *L. of C. Sub Area*
    D.A.D.H.
    Field Hygiene Section

APPENDIX 2

Means of determining the effect on health of atmospheric conditions

Wet and dry bulb thermometer

(i) This consists of two ordinary thermometers mounted on a frame side by side, a short space between them being necessary. One of these has its bulb covered with muslin and is kept constantly moist by being connected with a small vessel containing water. The moisture is maintained by the capillary action of a piece of cotton wick, which has been previously well freed from grease by being boiled in ether. The dry bulb gives the temperature of the air, whilst the wet bulb in consequence of the evaporation going on constantly from its surface, gives a lower reading.

The difference between the two temperatures recorded indicates the rapidity with which evaporation is going on. This increases when the air is drier, and vice versa, and can therefore be taken as a measure of the dryness or moistness (humidity) of the air. If the air is saturated with moisture, no evaporation goes on and the two thermometers will record the same temperature.

In frosty weather, the muslin covering and the water in the vessel will frequently freeze, with the result that evaporation will not take place. In such an event, it is sufficient to brush the frozen muslin over with cold water and to allow this to freeze ; at such time evaporation will be going on from the ice-surface, so that it is equivalent to having a damp but unfrozen bulb. Occasionally, in thick fog or during very damp cold weather, the wet bulb may read higher than the dry ; the temperature recorded by the latter is then to be taken as that of saturation.

Relative humidity.—This is merely a convenient term used to express comparatively dryness or moisture. Complete saturation being assumed to be 100 any degree of moisture may be expressed as a percentage of this. Thus, if the relative humidity is stated to be 71, it means that the amount of aqueous vapour present in the atmosphere is 71 per cent. of the amount which would be necessary to saturate completely the air at the particular temperature and pressure at the time the readings were taken.

In order to find the relative humidity, the use of tables, which

have been worked out from numerous observations and certain mathematical formulæ, is necessary.

These are known as hygrometric tables and will be found in any standard work on hygiene.

The Katathermometer

The Katathermometer, devised by Leonard Hill for indicating the cooling power of the air, is an alcohol thermometer with a cylindrical bulb 4 cms. long and a lesser expansion at the top. The stem has an upper marking for 100° F. and a lower for 95° F. Two such instruments are generally used—one with the bulb uncovered, the dry kata, and the other with the bulb covered with fine cotton mesh, the wet kata. The bulb of the katathermometer is immersed in water at about 150° F. until the spirit rises into the small expansion at the top of the stem; the bulb is then removed from the water and dried if the dry kata is being used, or excess moisture shaken off if the wet kata is being used, and the instrument suspended in the air. The rate of cooling from 100° to 95° F. is taken with a stop watch and recorded in seconds. This procedure is repeated six times; the first reading is neglected and an average obtained from the remaining five.

The total heat loss per square centimetre of bulb surface while cooling from 100° to 95° F. is determined for each instrument by the maker in terms of heat units or millicalories and marked on the back of the stem; this figure is known as the "factor."

~~The mean of the readings taken, divided by the factor, is the heat loss per square centimetre of bulb surface per second, or~~ the "cooling power." A high kata reading means great cooling power and a low kata reading the reverse. The dry kata loses heat by radiation and convection, while the loss of heat from the wet kata is by evaporation; the latter therefore most closely resembles the clothed human body. The body surface of the average man is 1·77 square metres and, as the dry kata cools four times as fast as the clothed body of a man, readings with this instrument should be divided by four when human comparisons are required. The wet kata is of special value in warm atmospheres and for testing air conditions associated with heavy work.

A satisfactory cooling power of the air depends on the nature of the employment of the occupants of the space concerned and on the temperature. For sedentary work indoors with a temperature between 60° F. and 70° F. a dry kata reading of 6 and a wet kata reading of 18 are required for comfort. If the feet are kept warm, higher cooling powers will prove comfortable.

Amdt. 1
Oct., 1936

The factor divided by the mean cooling time is the rate of heat loss per square centimetre of bulb surface per second, or

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Amdt. 1 Oct., 1936

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APPENDIX 3

Chief points in the spread of communicable diseases

Disease	Incubation period	Usual routes of infection	Special preventive measures
Anthrax ..	1–10 days	Carcasses, hides, hair of infected animals. Tooth or shaving brushes	Destruction of infected animals; disinfection of hides, wool, bristles, etc., bacteriological examination of tooth and shaving brushes.
Cerebro - spinal fever.	1–10 days	Carriers; droplet infection	Prevention of overcrowding; ventilation; isolation of carriers; disinfection of feeding utensils.
Chicken-pox ..	11–19 days	Contact, droplet, fomites	Isolation of cases until all crusts and scales have dropped off.
Cholera ..	1–5 days	Flies, dust, water, milk, vegetables, carriers	Protection of food and water supplies; isolation of carriers; inoculation.
Diphtheria ..	2–10 days	Contact, droplet infection	Isolation of cases and carriers; swabbing throats of contacts; ventilation; disinfection of feeding utensils; Schick testing and immunization.
Dysentery :			
Amœbic.	Uncertain, 3–12 weeks	Food, water, dust, flies, carriers	Protection of food and water supplies; anti-fly measures.
Bacillary ..	1–7 days		Isolation of diarrhœa cases and carriers.
Enteric (including typhoid and paratyphoid).	10-14 days	Food, water, flies, dust, carriers	As for dysentery; also inoculation.
Hydrophobia	6 weeks or much longer	Licks or bites of rabid animals	Tethering and observation of suspected animals for 10 days; control of dogs.
Influenza ..	1–5 days	Droplet infection	Prevention of overcrowding; ventilation; disinfection of feeding utensils; disinfection of barrack rooms.
Measles ..	7–14 days	Droplet infection	As for influenza; also isolation of persons with colds in the head.

Disease	Incubation period	Usual routes of infection	Special preventive measures
Mumps ..	12–26 days	Droplet infection	As for influenza.
Plague ..	1–6 days	Bubonic - infected rat fleas; pneumonic-droplet infection	Prevention of flea bites; destruction of rats and fleas; as for other droplet infection.
Relapsing fever	5–10 days	Lice or ticks	Prevention of bites and destruction of the insects.
Rubella ..	9–21 days	Droplet infection	As for measles.
Scarlet fever ..	2–7 days	Droplet, fomites and milk	As for influenza; protection of milk supplies; Dick immunity test.
Small pox ..	10–14 days	Contact, droplet, fomites	Vaccination.
Trench fever ..	5–12 days	Lice	Cleanliness; prevention or destruction of lice.
Typhus fever	5–12 days	Lice	As for trench fever.
Whooping cough	2–16 days	Droplet infection	As for influenza.
Yellow fever ..	2–6 days	Mosquitoes (*Ædes ægypti*)	Anti-mosquito measures.

APPENDIX 4

Instructions for the use of cart, water tank and water tank trailer

The present standard method of water purification, as practised in the Army on field service, can be summarized thus :—

(*a*) Preliminary clarification by alum, followed by
(*b*) sterilization by chlorine.

The Cart, Water Tank (Regimental Water Cart), is designed to embody these two principles (Plate I).

It consists essentially of two hand pumps and two clarifying cylinders, which deliver clarified water to a 110-gallon tank (100 gallons for use) where chlorination is carried out.

The tank, clarifying cylinders, pumps, etc., are mounted on a body frame supported by two wheels and drawn by two draught horses.

The cart holds sufficient water to fill the water-bottles of about 400 men. Two carts are provided for an infantry battalion.

(*a*) Clarification is effected as follows :—

A measured quantity of clarifying powder, consisting of two parts of aluminium sulphate and one part of anhydrous sodium carbonate, is placed in the covers of the clarifying cylinders ; the incoming water meets this powder and a precipitate of aluminium hydroxide is formed and deposited as a film on the surface of cloths wrapped round metal reels inside the cylinders. The aluminium hydroxide so formed acts as a filtering medium, and the water in its passage through the cloths is thus clarified and delivered to the tank for sterilization.

(*b*) Sterilization is effected as follows :—

A measured quantity of water sterilizing powder is added to the water in the tank. This powder consists of a mixture of four parts of bleaching powder and one part of quicklime, and contains, when freshly prepared, not less than 25 per cent. of available chlorine. It is this chlorine in the powder which brings about the sterilization of the water.

An important point to remember is that chlorine is absorbed by organic matter present in the water before it attacks living germs.

It has been found that, after allowing for absorption by organic matter, one part of chlorine in a million parts of water

is sufficient to make the water safe if left in contact with it for thirty minutes.

As no two waters are alike in the amount of organic matter which they contain, it follows that the quantity of chlorine required to sterilize the water will vary with the amount of organic matter present.

The varying requirements of different waters make it necessary to carry out some test in order to find out the quantity of chlorine which must be added to any given water to ensure sterilization.

The test devised for this purpose is known as the " Horrocks' Test," working instructions for which are given below.

Description of the cart and the tank

The cart consists of a galvanized iron tank, mounted transversely on a body frame and secured to it by steel bands.

The tank is divided into four compartments by cross baffle plates, which break up the water pressure when the cart is on the move ; it has a capacity of 110 gallons when filled to the lid, and about 100 gallons when filled to the top of the baffle plates. In practice the tank is always filled to its working capacity of 100 gallons. The compartments communicate with each other by means of openings situated at the bottom of the baffle plates. More openings are to be made in these plates to ensure more efficient mixing of the water sterilizant.

On the under surface of the tank, behind the axle, is fitted an elbow-connection for a draw-off pipe. This pipe is closed at each end by screw plugs and is furnished with four delivery taps from which water-bottles and other containers are filled.

A short length of flexible rubber tubing connects the draw-off pipe to the tank. A gun-metal stop-cock with key is fitted to the elbow-connection on the tank. In winter, this stop-cock can be closed to prevent freezing in the draw-off pipe and delivery taps.

Two drain-hole plugs are provided underneath the tank in front of the axle for emptying the tank after cleaning.

Two delivery pipes from the clarifying cylinders open into the top of the tank, one on each side of the lid.

The clarifying cylinders

Two metal clarifying cylinders, each provided with a pump, are fitted transversely on the body frame in front of the tank ; although they are usually worked together, each cylinder is independent of the other.

The clarifying cylinder consists of a body closed at one end (inlet) by a structure called the cylinder cover, and at the other end (outlet) by a screw plug.

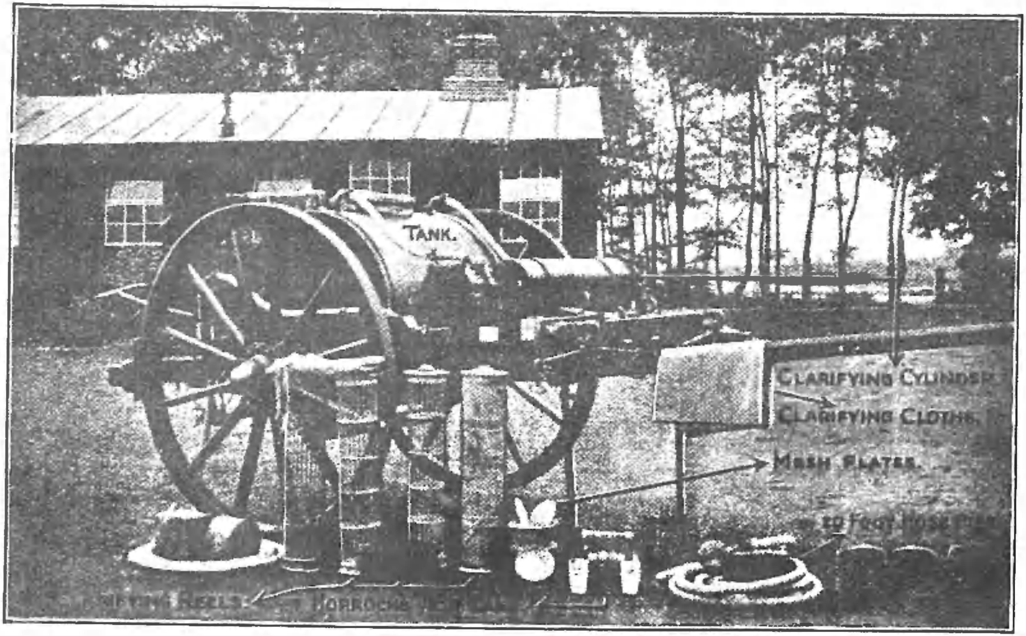

FIG. 68.—The regimental water cart.

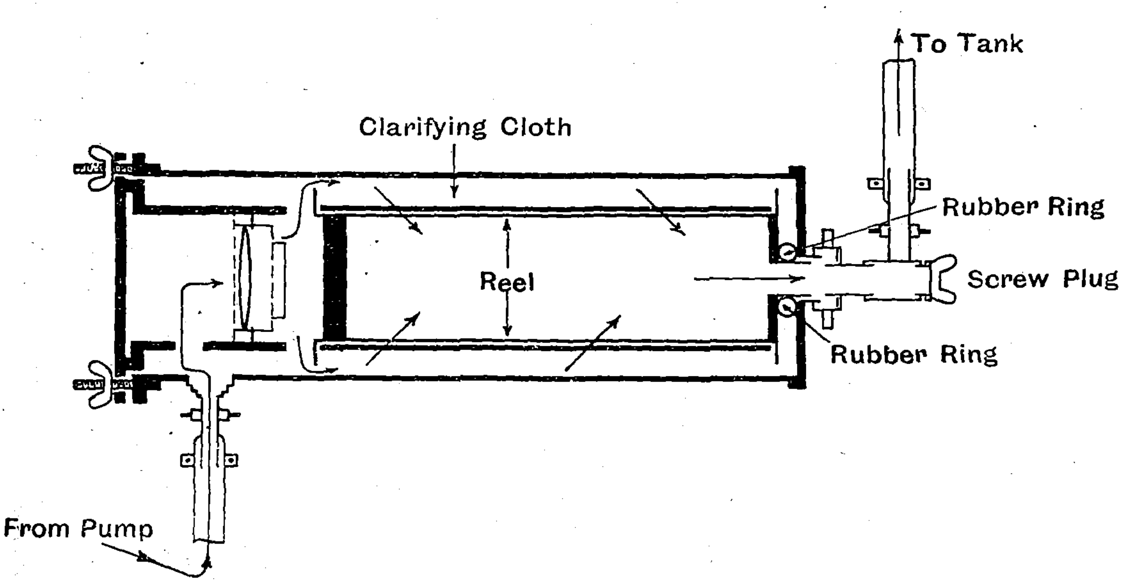

FIG. 69.—Clarifying cylinder showing reel and clarifying cloth in position. (Semi-diagrammatic.) Arrows denote course of the water.

Contained within the cylinder is a reel, which consists of a metal framework blocked at one end ; the other end is provided with an outlet through a spigot, round which is placed a rubber ring. It is round this reel that the clarifying cloth is wrapped.

The cylinder cover has on the inside a chamber with four large apertures at the side for the entrance of the water.

Contained within the chamber is a holder, consisting of two circular plates of wire gauze, between which the clarifying powder is placed. The outer wall of the chamber is perforated, and the inner wall consists of a movable cover, also perforated and held in position by a bayonet catch. The perforations in the outer wall ensure an even distribution over the holder of the stream of water in its passage through the chamber.

The cover is secured to the cylinder by six winged-nuts ; a leather washer making the joint watertight.

The hand pumps

Two pumps of the differential type are placed one on each side towards the rear of the cart.

Each pump is fitted with a relief valve, adjusted to blow off when the water inside reaches a pressure of approximately 15 pounds to the square inch.

The suction hose

Two 20-foot lengths of suction hose are provided for each cart ; when not in use, they are rolled and strapped on the cart in front of the tank.

One end of the hose carries a union for attachment to the pump ; at the other end are a float, strainer and perforated galvanized iron outside casing.

The strainer consists of two parts :—(i) an iron cage and (ii) a brass perforated tube.

The outside casing encloses the strainer and is fastened by a split pin.

The float is wired to the hose.

The draught pole, etc.

A draught pole, supporting bar and two swingle-trees are provided for a pair of draught horses.

The store box, etc.

A wooden box for carrying small spare parts and stores is mounted at the rear of the cart.

Fastened by straps to the top of the box is a kettle, in which the clarifying cloths are boiled.

On the off-side of the cart is a galvanized iron drinking cup secured by a chain.

On the near side, fastened by a strap, is a box to hold three pounds of grease.

Working instructions

1. Turn on the delivery taps and allow any water left in the tank to run to waste.

2. Throw the strainer into the source of water supply as far from the bank as possible. If the source is a swiftly flowing stream, the suction hose should be thrown over the bough of a tree or other support, in order to prevent the strainer from being washed to the side.

See that the leather washer is in position in the hose union and then pass the hose under the brake arm and attach it to the pump.

3. Remove the cylinder cover by unscrewing the winged-nuts.

Take out the reel and wrap round it the clarifying cloth. As efficient clarification depends to a great extent upon the proper wrapping of the cloth, the following precautions should be carefully observed :—

(*a*) The cloth should extend to each end of the reel and must be wrapped smoothly with as few creases as possible.

If the cloth is too wide, it should be turned back at one end.

If the cloth shrinks after repeated washing, put on two cloths and allow them to overlap in the centre of the reel.

(*b*) The clarifying cloth (which should go round the reel about three and a half times) is tied by five tapes sewn along one edge.

First tie the two outer tapes round the grooves at each end of the reel ; then tie the three inner tapes.

It is advisable to tie the tapes in bows, as in cold weather knots are difficult to undo.

4. Place in the clarifying cylinder the wrapped reel and push it well home, so that the rubber ring round the spigot comes in contact with the end of the cylinder.

5. Open the cylinder cover by removing the perforated cover and take out the holder.

Place four scoopfuls of clarifying powder between the wire gauze mesh plates, using the scoop contained in the half-pound tins of clarifying powder.

Then replace the holder in the cylinder cover, put on the perforated cover and fasten it down by means of the bayonet-catch.

6. See that the leather washer is in place on the cylinder cover, then fasten it to the cylinder by screwing up the winged-nuts.

In putting on the cylinder cover, screw up opposite pairs of winged-nuts together and take care that the brass washers are on the outside of the flanges of the cylinder cover.

The pressure of the cylinder cover forces the reel against the end of the cylinder, forming with the rubber ring on the spigot a water-tight joint.

If the rubber ring becomes flattened by repeated use, replace it by a new one.

7. Unscrew the plug at the outlet of the cylinder.

8. Start pumping slowly (about 18 strokes to the minute).

The water now enters the clarifying cylinder, passes into the cylinder cover and through the holder, dissolving the clarifying powder contained in it. The water then travels along the cylinder round the outside of the clarifying cloth, through which it is forced to the inside of the reel.

In its passage through the reel the water deposits a film of aluminium hydroxide on the surface of the clarifying cloth. The formation of this film on the clarifying cloth is the essential factor of clarification.

From the inside of the reel the water runs to waste at the outlet of the cylinder (Fig. 69).

9. Clarification is imperfect until the film of aluminium hydroxide is deposited on the clarifying cloth. As this usually takes a little time, the water should be allowed to run to waste until efficient clarification takes place, as shown by the issue of clear water.

The degree of clarification can be judged by taking samples of water from the outlet of the cylinder in one of the white cups provided in the Horrocks' test case.

When the water is clear, screw in the plug at the outlet of the cylinder; the water now stops running to waste and enters the tank through the delivery pipe.

10. If the water does not become clarified in a short time (say ten minutes), unscrew the cylinder cover, take out the reel and examine it. Imperfect clarification may be due to any of the following causes:—

- (i) Careless wrapping of the clarifying cloth round the reel. This allows water to enter the reel without having first passed through the clarifying cloth.
- (ii) A flattened or badly worn rubber ring round the spigot.
- (iii) Insufficient clarifying powder in the holder.

The first defect is remedied by re-wrapping the clarifying cloth correctly; the second by replacing the defective rubber ring by a new one; and the third by placing two or three extra scoopfuls of clarifying powder in the holder.

11. The escape of water from the relief valve of the pump is caused either by pumping too quickly or by the clogging of the clarifying cloth with dirt when a very turbid water is being clarified.

The remedy is to pump more slowly or to replace the dirty cloth by a clean one.

12. The water which first enters the tank should be allowed to run to waste through the delivery taps at the back of the cart, in order to flush out the bottom of the tank.

13. With the six white cups take samples of water from one of the delivery taps and carry out the Horrocks' test (*see* page 227).

14. Close the delivery taps and pump water into the tank until it is about half full.

15. The reading of the Horrocks' test will give the required numbers of scoopfuls of water sterilizing powder necessary to add to 100 gallons of water in the tank.

16. Take one scoopful of water sterilizing powder and make it into a paste in the black cup with a little clarified water; fill up to the mark with clarified water, stir, and pour the solution thus formed into the tank, distributing it equally between the four compartments. Repeat this process according to the number of scoopfuls required, as shown by the Horrocks' test.

The scoop contained in the ¼-lb. tin of water sterilizing powder must always be used for this purpose, and not the scoop of larger size contained in the tins of clarifying powder.

Take care that the water sterilizing powder used for adding to the water in the tank is taken from the same tin as that used for the Horrocks' test.

The powder should never be added in solid form to the water, but should always be made into a paste first in the black cup and then diluted with clarified water.

17. Now fill the remainder of the tank with clarified water. The entry of this water helps to mix the contents.

18. When the level of the water reaches the top of the baffle plates, pumping should be stopped. The tank now contains about 100 gallons. As it is very necessary to ensure thorough mixing of the chlorine with the water, the contents of the tank should be mixed by rapidly raising and lowering the cart by means of the draught pole.

19. **Leave the water in the tank for half an hour** in order to allow the necessary 30 minutes' contact with the chlorine.

20. At the end of this period, test the treated water as follows :—

First empty the draw-off pipe by turning on the delivery taps. This must be done in order to get rid of any unsterilized water which the draw-off pipe may contain.

Now draw off from one of the delivery taps a sample of water from the tank in a white cup and add to it three drops of the indicator solution (cadmium iodide and starch) contained in the Horrocks' test case. **If a faint blue colour appears, sterilization has been effected and the water in the tank is safe to drink.**

NOTE.—The development of a faint blue colour on the addition of three drops of indicator solution to a water which has been treated with water sterilizing powder and allowed to stand for half an hour indicates the presence of free chlorine, that is, chlorine over and above the amount which has been used up in sterilizing the water.

21. **If a blue colour does not appear on the addition of the indicator solution, then sterilization has not been effected and the water is unsafe to drink.**

Take, therefore, another scoopful of water sterilizing powder and make it into a little paste with clarified water and add it to the tank as before. Thoroughly mix the solution with the water in the tank as before.

Wait for half an hour ; then test the water again. If no blue colour appear this time, then another scoopful of water sterilizing powder must be added to the tank and mixed as before, and the water tested again at the end of half an hour.

22. Having satisfied yourself by the above test that the water is safe for drinking, you must now find out by tasting whether it is fit to drink.

23. Now unscrew the cylinder covers, take out the reels, unwrap the clarifying cloths and rinse them in water until free from dirt and the film ; then boil them for half an hour in the kettle.

Extra reels and clarifying cloths are carried with the spare equipment should more clarified water be needed.

NOTE.—A scrubbing brush for cleaning the clarifying cloths is provided with the spare equipment. As this tends to produce holes in the clarifying cloths, it should be used with care.

24. When circumstances permit, the water should be sterilized overnight and not drawn for drinking until the following day.

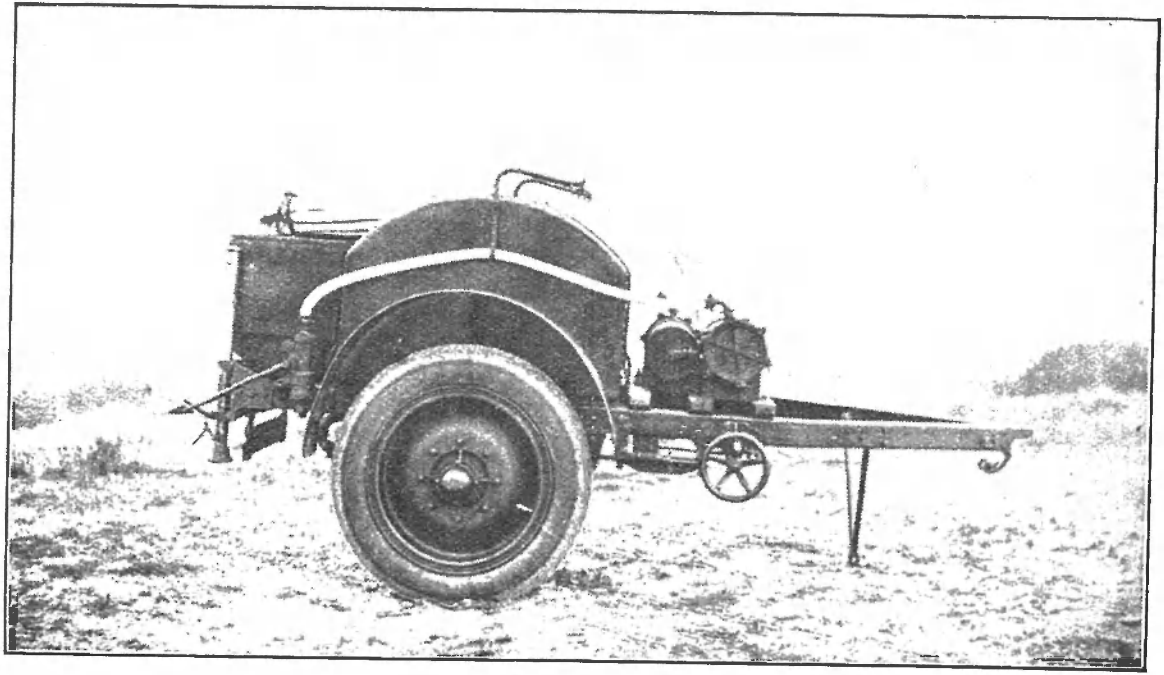

FIG. 70.—The water tank trailer.

25. If the water be used immediately after the lapse of half-an-hour, it may have a slight taste of chlorine. The taste disappears in time and the water then contains nothing but lime salts, which are present in every hard water. It is therefore advantageous to prepare water well in advance of the time when it is required.

Method of cleaning the tank

1. Fill the tank about half-full with clarified water.

2. Mix half a ¼-lb. tin of water sterilizing powder with some clarified water and add it to the tank.

3. Scrub the inside of the tank with the brush provided for this purpose, and, if possible, have the cart drawn some distance along the road in order to keep the water in the tank moving.

Take out the screw plugs at each end of the draw-off pipe, turn on the delivery taps and allow the water to flow.

4. When about half the volume of water has run to waste, unscrew the two drain-hole plugs at the bottom of the tank and allow the remainder of the water to escape.

5 Repeat the process without the powder, using clarified water only.

6. The framework and wheels of the cart should be cleaned with water and a carriage brush.

NOTE.—When in constant use, the tank should be cleaned at least once a week.

Description of the water tank trailer for use with mechanical transport

The water tank trailer is arranged to contain a supply of water clarified and sterilized in a manner similar to that carried out for the cart, water tank.

The tank is carried on a 15-cwt. two wheeled G.S. trailer with pneumatic tyres and has a total capacity of 180 gallons, with a working capacity of 150 gallons. It is equipped with pumps and clarifying cylinders similar to those supplied with the regimental water cart.

THE HORROCKS' TEST

Instructions for use with Case, Water Testing, Sterilization

The object of the test is to find out how much water sterilizing powder is required to sterilize 100 gallons of water.

Description of contents

The contents of the case are as follows :—

6 white enamelled cups, each holding ⅛ pint of water when filled nearly to the brim.

1 black enamelled cup, with a mark on the inside.

2 metal scoops, each holding 2 grams when filled level with the brim with water sterilizing powder. They are similar to the measure contained in the ¼-lb. tin of water sterilizing powder.

1 stock bottle of cadmium iodide and starch indicator solution, and 1 drop-bottle. 3 drops of the indicator solution give a definite blue colour with water containing 1 part to 1,000,000 of free chlorine.

6 glass tubes, or pipettes, each of such dimensions that a drop of standard water sterilizing powder solution delivered by it, when held in a vertical position, into a white cup filled with water, gives a dilution of chlorine of 1 part in 1,000,000, provided that the water sterilizing powder is up to strength.

4 glass stirring rods.

Tablets, sodium thiosulphate, gr. 1½, No. 25.

Tablets, acid sodium sulphate, gr. 15, No. 50.

12 pipe cleaners.

2 copies of instructions.

Method of using

Clarified water from the cart is used The test is best carried out while the cart is being filled, an operation which takes about half an hour.

1. Prepare a standard solution of water sterilizing powder in the black cup as follows :—

Put into the black cup one level scoopful of the solid water sterilizing powder, and make it into a smooth paste with a little clarified water by stirring it with a glass stirrer and carefully breaking up all lumps. Add more water to the paste and fill the black cup with water to the mark on the inside. Stir vigorously and leave the glass rod in the black cup. This solution is never clear, as it contains lime in suspension, which, however, gradually settles. Put into this solution one of the glass pipettes.

2. Fill the 6 white cups with clarified water to within a quarter of an inch of the top.

3. Add drops of the standard water sterilizing powder solution from the pipette to the water in the white cups, so that they contain 1, 2, 3, 4, 5, 6 drops respectively. Stir the contents of each thoroughly with a clean stirring rod and leave this stirring rod in the black cup. Allow the cups to stand for half an hour.

Note.—In order to add even drops of the standard water sterilizing powder solution to the cups, it is necessary that

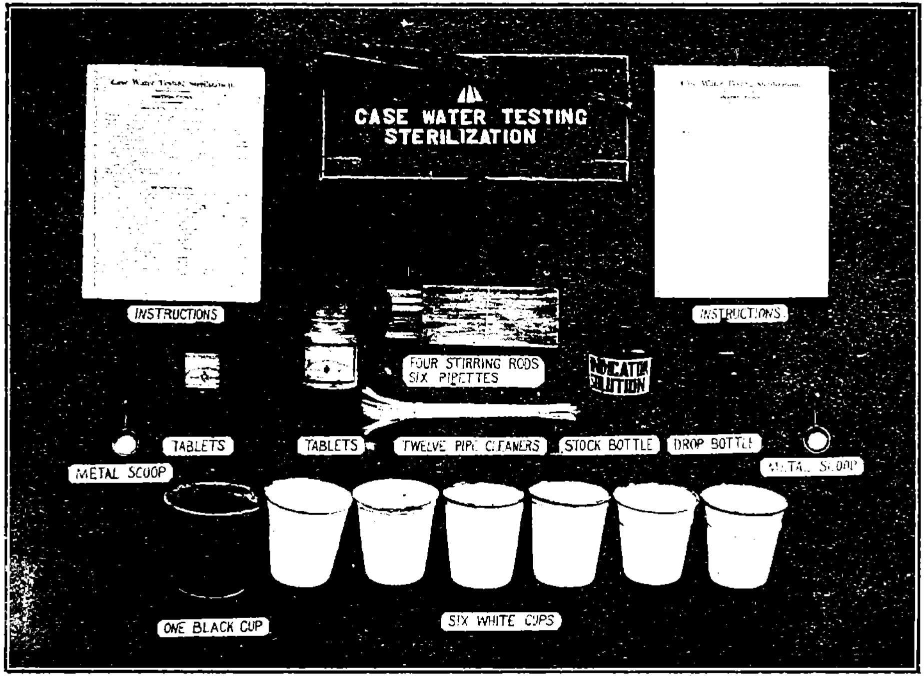

FIG. 71.—Contents of case, water testing, sterilization (Horrocks' box).

the top of the pipette and also the finger should be quite dry. Pressure of the finger on the pipette keeps the liquid from running out. By gradually releasing the pressure, a continuous series of drops can be made to fall from the pipette. A novice can soon learn the method of dropping by practising a few times with the solution out of the black cup.

4. After half an hour add 3 drops of the indicator solution from the drop-bottle to each of the white cups, and stir each with a clean stirring rod.

5. Some of the 6 white cups will show no colour, some will show a blue colour. The first of the cups showing a blue colour, that is the one containing the smallest number of drops, is noted. Say cups 1, 2, 3 show no colour, but cups 4, 5, 6 show a blue colour, then cup No. 4 is the one to be noted. If none of the cups shows a blue colour, the cups are washed out and the test is performed again with 7, 8, 9, 10, 11, 12 drops of the water sterilizing powder solution in the cups.

6. Each drop of water sterilizing powder solution in a white cup corresponds to a scoopful of water sterilizing powder to a full water-cart of 100 gallons. 4 scoopfuls of water sterilizing powder, corresponding to the 4 drops, are thus required for the tank of the cart in the instance given in the previous paragraph.

Estimation of available chlorine in Water Sterilizing Powder

Method

(a) *To make the standard sodium thiosulphate solution.*—Dissolve one tablet of sodium thiosulphate, 1·5 grains, in the cleanest water available in one of the white cups in the case. Dilute until the cup is full to the brim and mix thoroughly by stirring gently. (Strength, 0·05 per cent.)

(b) *To make the standard water sterilizing solution.*—Measure out a level scoopful of water sterilizing powder into the black cup of the test box. Mix into a thin paste with water and dilute to the white line in the usual way. After it has been standing a few minutes, during which time the two scoops should be cleaned and rubbed over with a greasy rag, stir the solution of water sterilizing powder thoroughly and transfer a level scoopful of it to a clean white cup about a quarter full of clean water.

(c) *Titration.*—Pour into the white cup containing the diluted water sterilizing powder solution about a scoopful

of the cadmium iodide and starch indicator solution and add one acid sodium sulphate tablet. Stir till the tablet is completely dissolved. The contents of the cup turn blue-black. Now add level scoopfuls of standard thiosulphate solution, stirring between each addition and counting carefully the number added. When the colour just disappears, the number of scoopfuls of thiosulphate solution added represents the percentage of available chlorine.

Example.—The experiment required 26 scoopfuls of thio sulphate to discharge the blue-black colour; the powder contains therefore about 26 per cent. available chlorine.

N.B.—Sterilized water must not be used in carrying out this test.

Indicator Solution

(Cadmium Iodide and Starch Solution)

Cadmium Iodide, recrystallized	1½ oz.
Starch, soluble	⅓ ,,
Water	1 pint

To ⅓ oz. of soluble starch add 2 to 3 oz. of cold water and stir well.

Take a clean vessel, place in it one pint of water (less the quantity already added to the starch) and bring it to the boil.

To this slowly add the starch—cold water mixture—stirring continuously.

Continue boiling gently for 15 minutes.

Cool, add 1½ oz. of recrystallized cadmium iodide and dissolve by shaking.

The solution should be tightly corked and kept in the dark.

APPENDIX 5

The Elliott Mobile Water Purifier

For the treatment of water by the addition of chloramine and subsequent filtration

Capabilities

The delivery of 1,200 gallons of filtered and sterilized water an hour, from a depth of 10 feet, to a height of 20 feet. Storage of the water for one hour is required, to let the sterilizing agent act.

The water is free from taste and odour.

The plant is self-contained, and weighs about 1 ton. It can easily be mounted on a 30-cwt. 6-wheeled chassis for transport.

The provision of a trailer for stores is an advantage, the personnel being carried on the chassis of the purifier.

Personnel

R.A.M.C. One N.C.O. and one other rank.

R.A.S.C. One other rank (driver).

The personnel should be conversant with the working of the plant and be able to do running repairs.

The principle of the plant

A small petrol engine drives a dynamo and pump. As the water is sucked into the pump, it is dosed with a sterilizing agent " chloramine " produced by the interaction of ammonia and sodium hypochlorite. The latter is made by the electrolysis of a dilute salt solution. By increasing or decreasing the electric current the amount of chloramine can be regulated as desired ; about 2 parts in 1,000,000 are normally required.

The water thus treated is then forced through a cloth filter, which is in duplicate. If one filter becomes blocked, the other can be taken into use, thus ensuring a continuous flow of water.

The chemicals used are ammonium sulphate and salt, both of which are cheap and readily obtainable. To dispense with scales and weights, saturated solutions of these are carried in stoneware jars and diluted as required.

Description of the apparatus

The purifier is made up of three main parts :—

(*a*) The apparatus for making and introducing chloramine.
(*b*) The engine, dynamo and pump with foot valve
(*c*) The filter.

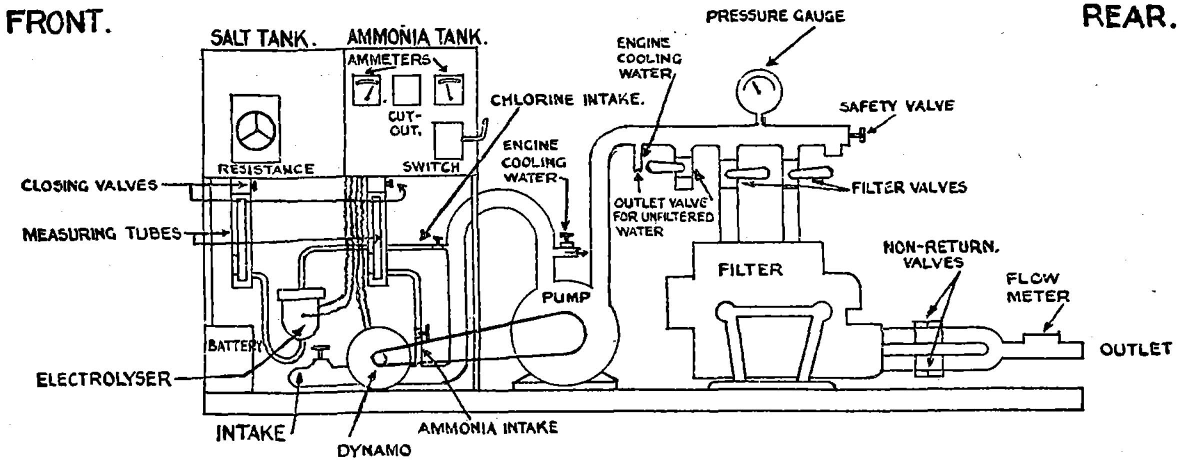

Fig. 72.—Elliott mobile water purifier.

(*a*) The chloramine apparatus comprises storage and feed tanks for the ammonia and salt solutions and their respective valves, and an electrolyser and its valves.

The feed valves are so arranged as to give a constant flow of the necessary solutions.

The access of dust and leaves must be prevented, and the solutions strained before use.

The electric current for the electrolyser is derived from the dynamo; an ammeter and resistance are provided to regulate the current and so ensure the requisite dosage of chloramine.

(*b*) The petrol engine, dynamo and pump stand on one bed-plate with a shaft common to all three. The dynamo is a direct current, 30 amperes, 4 volts machine with a variable resistance controlling the output of current to the electrolyser

The pump is of the self-priming rotary type and gives a non-pulsating flow.

The intake pipe from the pump leads to the two filters, but may be disconnected from either as desired.

N.B.—(The foot valve must be kept clear from the bottom of the stream, etc., when the plant is in use.)

(*c*) The filter consists of 12 coarse canvas cloths stretched upon aluminium plates. These are tightly screwed together.

Channels in the sides of the plates provide for the entrance and exit of the water.

In order to replace the cloths when blocked, the whole filter is unscrewed, the dirty cloths removed and clean ones substituted, the operation taking between 10 to 15 minutes when carried out by a trained man. The dirty cloths are cleaned by scrubbing in cold water.

A pressure gauge is provided on the feed-pipe to the filters, and, when the pressure reaches 25 pounds to the square inch it is necessary to change over to the duplicate filters.

A flow-meter is also provided directly indicating the rate of flow of the water.

APPENDIX 6

The Harold-McKibbin Method of water purification with chloramine

In the purification of water, it has been found that the combination of preliminary ammonia treatment with chlorination offers many advantages over ordinary chlorination.

A method has been devised which is based on this principle, and which can be used in connection with the regimental water cart or with any of the various tanks or containers used on field service.

Since the method is essentially one for use on field service, it is manifestly desirable that costly or fragile apparatus should not be required, and that any unnecessary complications, such as the necessity of having to use a special mixing tank, should be avoided. In this method of treatment the absorption of chlorine is retarded and consequently a test to determine chlorine dosage is rendered unnecessary.

The preliminary ammonia treatment is most conveniently carried out by means of tablets of one of the ammonium salts which possesses the necessary degree of stability and solubility. Ammonium chloride has been selected and the tablets of this salt are of a definite weight.

Chlorosene (super-tropical bleach 30 per cent. available chlorine) is used for chlorination and the dose is measured in the usual way by means of a 2-gram scoop. This preparation of chlorine is particularly stable and therefore suitable for use in the tropics.

The size of the ammonium tablets and of the chlorosene scoop are so related that, when one tablet is used in conjunction with one scoopful of chlorosene, the proportions of ammonia to chlorine in the treated water are as 1 to 5.

With regard to dosage, it should be remembered that chloramine is rather slower in its germicidal action than chlorine. If adequate time of contact can be allowed, very small doses of chloramine will be sufficient to ensure the death of all pathogenic organisms. On field service, however, water is often required for use immediately after treatment or after about one hour, so that the dosage here given is based on this requirement. It must be pointed out, however, that, when water is not required for several hours after treatment, half these doses would suffice to achieve the above results.

The standard dose for 100 gallons of water for use one

hour after treatment is 2 tablets of ammonium chloride followed by 2 scoops of chlorosene. This gives a titration of 1·3 to 1·4 parts of chloramine per million in the treated water.

Half these doses (1 tablet of ammonia and 1 scoop of chlorosene) gives a titration of 0·7 to 0·8 parts in 1,000,000.

It should be possible to demonstrate the continued presence of the sterilizing agent in the treated water in either case several days after treatment.

The materials required are :—

Chlorosene (30 per cent. available chlorine).
A scoop (measuring 2 grams).
Ammonium chloride tablets (each 0·35 grams).
2 Horrocks' cups and 2 glass stirring rods.

Method

" A " applied to water cart

The cart is filled two-thirds full in the usual way. 2 tablets of ammonium chloride are dissolved in a Horrocks' cup of water and the solution is divided equally between the **four compartments of the water cart.** 2 scoopfuls of chlorosene are mixed in a Horrocks' cup with the aid of a glass stirring rod and the solution is similarly divided between the same compartments.

The filling of the cart is then completed, and the sterilizant is by the act of filling automatically mixed with the water in all four compartments.

NOTE.—Owing to the completeness of the baffling of the existing water cart and the limited communication between the compartments, difficulty is experienced in obtaining equal admixture of the sterilizant with the water, even when the time and method of dosing given above is adopted.

" B " method for larger tanks

Since the dose for the water cart is also the dose for 100 gallons, and given the capacity of a larger tank, it is easy to calculate the proportionately larger dose required in tablets and scoops. The dose of ammonia should be added any time after the tank is one-quarter full and subsequently the dose of chlorine is added. Adequate admixture should be obtained by filling, in a tank without baffles.

" C " method for tanks of smaller capacity than the water cart

Here, a modification of the black cup method could be used. 2 tablets of ammonium chloride are dissolved in a black cup full of water. 2 scoopfuls of chlorosene are mixed in another

black cup. 1 scoopful of each solution is required for each gallon of water to be sterilized, ammonia solution being added first.

Alternatively.—The strong solution method may be used: a water cart dose of ammonia (2 tablets) is dissolved in a water bottle, which is filled.

Similarly the corresponding dose of chlorosene (2 scoops) is added to another water bottle.

10 cubic centimetres of each of these strong solutions are required for every gallon of water to be sterilized (add ammonia solution first).

It would be more convenient to improvise a measure holding the necessary quantity of solution for the tanks in use, *e.g.* a pakhal of 6 gallons.

A measure holding 60 cubic centimetres would deliver the correct doses of ammonia and chlorosene solutions to sterilize the contents of a pakhal.

APPENDIX 7

Rules for mineral water factories

(These apply to small factories or regimental factories)

1. *Arrangements*

The factory should be arranged so that (*a*) clerical work, (*b*) the washing of bottles, (*c*) syrup making, and (*d*) the filling of bottles are carried out in separate rooms or in well-defined parts of the same room, the different parts of the work being kept absolutely separate from each other.

2. *Bottle washing*

3 tubs should be provided :—

(*a*) The first of these should contain clean water to which washing soda has been added in the proportion of half an ounce to one gallon of water and all bottles, on return to the factory, should be placed in this to soak The outsides of the bottles should be scrubbed with a hand-brush before being transferred to (*b*).

(*b*) The second tub should contain potassium permanganate solution, and here the bottles should be thoroughly cleaned inside with good bottle-brushes, rinsed in the solution and passed into the third tub.

(*c*) This tub should contain water sterilized by chlorination in the ordinary way. All the bottles should be rinsed out in this and then placed on a bottle rack, or draining table, to drain.

3. *Syrup making*

With the exception of the boiling of the sugar solution, all syrup making should be carried out on a clean table. Syrup strainers should be washed daily in clean sterilized water and protected from dust when drying or not in use. Syrup should be transferred to bottles by means of a long-handled ladle and a funnel. Syrup jars and bottles should be kept covered with muslin to keep out flies.

4. *Care of equipment*

(*a*) All brushes should be cleaned thoroughly in warm water after use and should be put away in wide-necked bottles or dust-proof boxes.

(*b*) All tubs and water containers should be washed out at least twice weekly with a strong solution of bleaching powder or potassium permanganate.

(*c*) Filter candles will not be used as a rule, but, where their use is permitted for some special reason, these candles will be removed from the filter twice weekly, brushed with a soft brush to remove all deposit, and boiled for ten minutes.

5. *Personnel*

(*a*) All personnel employed in mineral water factories must be examined as to their freedom from the organisms of the enteric and dysentery groups of diseases and protected against the enteric group by inoculation with T.A.B. vaccine. A list of such employees with the dates of examinations and inoculation will be hung up in each factory.

(*b*) No man who has suffered from enteric fever or other diseases of the enteric group will be employed.

(*c*) All employees will wear clean overalls when in the factory. These overalls should be kept in the factory and men should never be allowed to take them to their quarters.

APPENDIX 8

Sanitary rules for cook-houses

(To be hung up in a prominent position in all cook-houses.)

1. No one must be employed in any capacity in the cook-house or in handling the food of the troops who has suffered from typhoid fever, paratyphoid fever or dysentery, or who is suffering from or under treatment for syphilis.

Before men are so employed, they and their medical history sheets will be inspected by a medical officer, who will certify that they are fit or otherwise for the purpose.

2. A nominal roll of all such men will be hung up in the cook-house. This roll will contain columns for the dates on which the men were taken on or struck off these duties, and a column for the initials of the medical officer who passes the men as fit for the duties.

3. Each cook and man employed in handling the food of the troops will be provided with at least 3 sets of washable overalls. These overalls will always be worn at work. They will be kept as clean as possible, and changed when dirty.

4. A basin and clean water, soap, a nail brush and a clean towel, will be provided in each cook-house. All men employed as cooks and in the handling of food will keep their nails trimmed and will invariably wash their hands before they handle the food.

5. No personal clothing, necessaries or private property of men employed in the cook-house will be kept there; nor will men perform their toilet or wash and dry their underclothing in the cook-house.

Greatcoats, jackets and trousers, which are taken to the cook-house and removed before overalls are put on, will be kept in a special place provided for the purpose.

6. Smoking in the cook-house is forbidden.

7. The cook in charge will be responsible that there is always a sufficient supply of clean cloths available for washing and drying dishes and cooking utensils. The cloths used for handling hot and sooty vessels will be separate and distinct. After the last meal cloths must be boiled in water containing washing soda and hung up to dry.

8. All pots and pans will be freed from grease, cleaned and dried after the last meal, and placed on a shelf on their sides with their interiors exposed to the air and to view.

9. The cook-house sinks, tables, chopping blocks, cutting-up boards, pastry slabs, mincing machines, knives, forks and spoons, and all other utensils will be kept as clean as possible when in use and will be thoroughly cleaned after the last meal. All utensils, when not in use, will be kept in the places allocated for them and will be available for inspection at any time.

10. Only food which is to be used during the current day will be kept in the cook-house.

When not in process of cooking or in preparation for cooking, it will be protected from flies in fly-proof food safes.

11. Vegetables must never be prepared in the same sink or receptacle in which pots and pans are cleaned.

12. Food scraps, vegetable peelings and such like refuse will not be thrown on the floor, but deposited in covered refuse bins provided for the purpose.

13. All cutting up of meat and pastry will be done on the cutting-up boards and pastry slabs provided for the purpose and never on the cook-house tables.

14. The diet sheet for the week will be hung up, available for reference in the cook-house.

15. Any defect in the cooking apparatus or in the utensils will be reported at once by the cook in charge to the unit quarter-master, who will take the necessary steps to have the defects remedied.

16. When possible, coal will be kept in a store outside the cook-house. Where only old-pattern coal boxes inside the cook-house are available, they should be covered.

17. The floors of cook-houses will be cleansed by scrubbing with hot water containing soda or soap and cresol solution. All excess of water must be dried up after scrubbing.

APPENDIX 9

Prevention of scurvy

Scurvy may be prevented by the issue of fresh fruit and vegetables and of fresh meat.

When these cannot be obtained, a daily issue of one ounce of lemon-juice should be made. Where lemon-juice is not available, pulses, prepared as under, will also prevent this disease :—

1. The dry seeds (peas, lentils, etc.) must be whole, retaining the original seed coat, not milled or decorticated.
2. They must be soaked in water for several hours ; the time necessary depends on the temperature, 24 hours at 50° F. to 60° F., and 12 hours or less at 90° F.
3. The water must be drained away and the peas, etc., allowed to remain in the moist condition, with access of air. They will then germinate and the small rootlets will grow out. This germination will take 48 hours at 50° F. to 60 ° F., and 12 to 24 hours at 90° F.
4. The operations described in (2) and (3) can conveniently be carried out under active service conditions in such manner as the following :—

   Soaking.—The peas, beans or other pulses, placed in a *clean* sack, should be steeped in a trough, barrel or other suitable vessel, full of clean water, and should be occasionally stirred. The sack and trough, etc., should be large enough to allow for the swelling of the peas to about three times their original size. In a hot climate 6 to 12 hours should suffice for this soaking.

   Germination.—The peas should be lifted out of the water and spread out to a depth not *exceeding 2 to 3 inches* in a trough or other vessel with sides and bottom porous or well perforated with holes. This is to allow complete access of air. *The seeds must be kept in a moist atmosphere.* This is done by covering with damp cloth or sacking, which is sprinkled (by hand or automatically) as often as is required to keep the peas or beans thoroughly

moist underneath. The germination should reach the stage mentioned in (3) above within 24 hours in a hot climate.

All the vessels should be clean.

5. It is important that the germinated pulses should be cooked and eaten as soon as possible after germination, and should not be allowed to become dry again, as in that case the anti-scorbutic properties acquired during the process of germination will again be destroyed. The pulses should not be cooked longer than necessary, and in no case for a longer period than 15 minutes.

APPENDIX 10

Spacing allowed for British Troops

	Floor space per head (sq. ft.)	Cubic space per head (cu. ft.)
1. Barrack Rooms—		
A. Home stations	60	600
B. Gibraltar and Malta	60	720
C. Cyprus, Ceylon (hill stations), Hong Kong Peak and Bermuda ..	70	840
D. North China	70	770
E. Egypt, Ceylon (coast), South China (excluding Hong Kong Peak), Mauritius, West African hill stations and West Indies	80	1,040
F. Soudan, West Africa (plains) and Straits Settlements..	100	1,400
2. Guard rooms and guard detention rooms (home stations)	80	800
3. Offices	50	500
4. Classrooms in army children's schools ..	12	144
5. Army hospital wards (home stations) ..	100	1,200

NOTE.—Not less than 6 ft. linear wall space for each bed.

APPENDIX 11

Sea transport—regulations relating thereto and reports and returns to be rendered

1. Regulations and Instructions for H.M. Sea Transport Service (1929).

2. Circular Memorandum (120/Gen. 8711) of October, 1920.

3. Revised Specifications of Sea Transport Regulations, January and February, 1925.

4. King's Regulations, 1928, paras. 1083 to 1186.

5. Voyage Regulations, 1928.

6. Field Service Pocket Book, 1932, Section 36.

7. Regulations for the Medical Services of the Army, 1932, Section XIII.

REPORTS AND RETURNS

1. Arrangements for troops satisfactory.

Board of Trade representative. Embarkation staff officer. Embarkation medical officer. O.C. troops. Senior medical officer.	To	Director of Movements and Quartering. Director of Hygiene. (King's Regulations, 1928, para. 1145.)

2. Prior to embarkation.
   (*a*) Certificate of fitness of families to embark. (Army Form B 155.)
   (*b*) Inoculation State, Army Form I. 3956, to Embarkation Staff, copy to S.M.O. ship. (King's Regulations, 1928, para. 1145.)

3. Final inspection of ship, signed as 1 above.

4. Certificate T. O.C. troops to staff officer at port after occurrence of infectious disease. (Voyage Regulations, 1928, para. 275.)

5. Voyage report, on Form T. 211 by :—

O.C. troops. S.M.O. Master of ship.	Quadruplicate through Disembarkation Staff Officer.	To War Office. Q.M.G. 2. A.M.D. 5.

If disembarkation is in India, extra copies are sent to Q.M.G. India and G.O.C. port of disembarkation.

6. Health report by S.M.O., through embarkation medical officer at port of disembarkation, to War Office, A.M.D. 5 for information of D.G., A.M.S.

APPENDIX 12

Method of treatment of waste water containing fat or soap with ferrous sulphate (sulphate of iron or copperas) and lime

1. The waste water is collected in a tank with the outlet a few inches from the bottom.

2. Ferrous sulphate and lime are crushed by placing them in paper and stamping on them.

3. A scoop from a tin of water clarifying powder (83 grains) is used for measuring the ferrous sulphate ; 3 level scoops equal 1 ounce of ferrous sulphate.

4. A scoop from a tin of water sterilizing powder (30 grains) is used for measuring the lime ; 15 level scoops equal 1 ounce of lime.

5. A sample of the waste water to be treated is put in a 5-gallon drum.

6. One scoop of ferrous sulphate, dissolved in a little water, is added to the waste water in the 5-gallon drum.

7. One scoop of lime is emulsified with water, added to the drum and stirred well. If no dark green precipitate forms, further scoops of lime are added until the precipitate forms.

8. Allow the water to stand for a few minutes and then, if the supernatant water is not quite clear, add more ferrous sulphate and then lime as above, repeating until the top water is clear.

9. The amounts of ferrous sulphate and lime required for all the waste water can be estimated from the amounts required for the 5-gallon sample.

10. The requisite amounts are then added to the tank of waste water and stirred. The clear effluent is run off in half an hour.

APPENDIX 13

Working of the Horsfall destructor

A fire is started in the destructor with paper, straw, wooden boxes or other inflammable camp refuse from a refuse bin kept near the destructor. The buckets from the latrines are meanwhile delivered on the platform immediately in rear of the refuse bin and dealt with as described in Chapter VIII (p. 102).

When the fire has burned up brightly, half the contents of a full bucket are tipped into the destructor, care being taken to do this slowly so as not to overload the fire. In about a quarter of an hour (the time, of course, depending on the heat of the fire), another half-bucketful is added. Between the charges of fæces, camp refuse is added in small quantities to keep up the body of the fire.

The destructor must be stoked carefully; otherwise the fæces will fall in a cake to the bottom of the fire, although this is more or less prevented by the supporting bars which have been added to more recent models. When the destructor is working properly, all the smoke is consumed in the chamber below the chimney.

Considerable judgment is necessary in filling the destructor if the best results are to be obtained.

The destructor is capable of burning the camp refuse and fæces of a battalion without the aid of extra fuel, provided the camp refuse is of good quality and dry, but to make sure of complete destruction it is advisable to use at least 1 cwt. of wood, coal, or a mixture of both, each day in addition to the camp refuse.

To keep the fire in during the night, the air inlets should be blocked up and the destructor attended to last thing at night and early in the morning.

The buckets, after being emptied, are taken to the washing platform, where they are scrubbed out with a minimum of water, cresol solution and a little sawdust. They are then filled to a depth of 3 inches with dilute cresol solution and taken back to the latrines; if crude oil is available, the interior of the bucket should be rubbed over with it before the cresol solution is put in, for the crude oil facilitates cleansing and helps to keep away flies.

APPENDIX 14

Materials for dealing with animal carriers of disease

Flies

Arsenic solution.—Arsenic is usually supplied in the form of tablets of arsenite of soda, coloured with an aniline dye and sweetened. One tablet dissolved in 3½ ounces of water (6 tablets to one pint) makes a 1 per cent. solution. Remember that arsenic is a deadly poison.

Formalin solution.—Formalin is a solution of a gas (formaldehyde) in water and therefore deteriorates if the bottle is left uncorked.

Formalin	1 dessert spoonful
Sugar	1 ,, ,,
Water	1 pint

Lime water should be used in preference to plain water, or half a teaspoonful of washing soda may be added to the mixture, to prevent the solution turning acid.

Fly spray (Lefroy's fluid)

Pyrethrum powder	2 lbs.
Methylated spirit	1 gallon
Saffrol	1 ,,
Aniline	1 oz.

For use, dilute with 20 volumes of water or preferably of soap solution; 10 cubic centimetres (⅓ ounce) of the undiluted solution is sufficient to spray 1,000 cubic feet.

Stick-fast (Tanglefoot) for fly wires and papers

Castor oil	5 parts	by weight.
Resin	8 ,,	

The actual proportion of the ingredients should be given a trial at the local temperatures. Crude castor oil and common resin are better than chemically pure. The stick-fast should be made in double tins with water in the outer tin. The castor oil is heated to simmer. Then the powdered resin is added and stirred in. Then simmer, but do not boil, for 15 minutes. Pour into cigarette tins for keeping. Heat again slightly for spreading on wires or papers.

Mosquitoes

Oiling

(*a*) Crude heavy oil	..	2 parts	By adding castor oil (crude) 2 per cent. the spreading power is increased.
Paraffin oil	..	1 part	

Half a pint will cover 100 square feet or half an ounce a square yard.

For drip cans allow drip at 20 drops a minute.

(*b*) For drinking-water wells—cotton seed oil, half an ounce a square yard.

(*c*) Liquid paraffin may also be used for drinking water once weekly, about one teaspoonful to the square yard.

Poisons

Paris green is a double salt of copper arsenite and copper acetate and should contain the equivalent of 50 per cent. arsenious oxide for use as a larvicide.

It is used in a 1 to 5 per cent. mixture made up with road dust, sawdust, lime, wood ash or very fine sand.

Cresol

Cresol for mosquito pools.—Estimate the approximate water content of the pool and allow 1 gallon of cresol for each 8,000 gallons of water. Cresol must be made up into an emulsion with five times its bulk of water before being put into the pools and must be well mixed in the pool.

Sprays

" Flit " substitute

Oil of wintergreen	1 per cent.
Paraffin oil	99 ,, ,,

Oil of wintergreen, although more expensive, is more effective than the synthetic preparation, methyl salicylate.

The paraffin oil should be of a grade with flash point of 128° F. and specific gravity 0·82.

This preparation should be used as a spray ; it may leave stains on fine fabrics.

Soapy hand method for mosquitoes

Two men do a barrack room or a tent. One stirs the mosquitoes out of the dark corners with a stick. The other lathers his hands copiously with soap and then catches the flying mosquitoes in the soap on his hands. Little skill or exertion is required.

Inter-company competitions may be introduced. The results are amazingly good and catches of over 400 mosquitoes a day from one barrack room have been made.

Mosquito netting

Wire gauze.—The mesh is calculated by counting the number of holes to a linear inch. The size of the opening depends upon the count to the inch and the thickness of the wire.

A mesh of 14 holes to the inch, with wire of 30 I.S.W.G., will exclude mosquitoes.

Cotton netting.—The mesh will be seen to consist of two series of holes, the lines intersecting each other at an angle of about 60 degrees. The mesh is the sum of the numbers of holes counted along both lines within an area of one inch square; the hole at the angle of the square, where the two lines meet, is counted twice (Fig. 73).

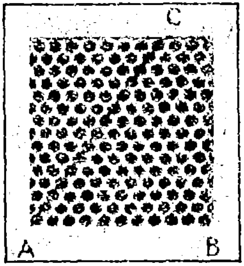

FIG. 73.—Mesh of cotton mosquito netting to show method of counting. The mesh of this net is the sum of the counts made along the lines AB and AC, the hole at A being counted twice.

Cotton thread is standardized according to weight, being described as " 30," " 40," " 50," etc., the higher number being the thinner thread. Netting where both warp and bobbin are the same thread is described, for example, as " 30's "; if, for example, " 40 " is used for warp and " 60 " in the bobbin, the netting is said to be woven of " 40/60."

The size of the holes clearly depends upon the count and the thickness of the threads.

Cotton netting of a mesh of 28 to 29 holes in the square inch, counted as above, and made of 30/40 cotton, will exclude mosquitoes under natural conditions.

Mosquito nets may be fire-proofed by dipping them into a

solution of sal-ammoniac (1 ounce to a pint of water), wringing lightly and allowing to dry.

A mesh of 46 holes to the square inch, counted as above, and made of 120's cotton will exclude *Phlebotomi*.

Lice

Vermijelli

Soft soap ..	24 per cent.	This is rubbed into the seams of the clothing, but is irritating to the skin.
Heavy oil ..	70 ,, ,,	
Water ..	6 ,, ,,	

N.C.I. powder

Crude unwhizzed naphthalene in powder ..	96 parts
Creosote	2 ,,
Iodoform	2 ,,

Fleas

Soft soap and paraffin emulsion for fleas (*Pesterine*)

Soft soap	$1\frac{1}{4}$ lb.
Paraffin oil	4 gallons
Hot water	1 gallon

Dissolve the soap in the hot water—add very gradually the paraffin oil, with continuous stirring. For use dilute to 5 per cent. with water.

Cresol and soft soap emulsion for fleas

Cresol	5 parts
Soft soap	20 ,,
Water (hot)	75 ,,

The cresol and soft soap are added to the hot water with continuous stirring.

For use make a 5 per cent. solution with water.

APPENDIX 15

Disinfectors, Table of Particulars.

Types of machine	Manlove, Alliott & Co. (Alliott & Paton H.P. Steam)					Thresh Disinfector Co.			Grampian Engineering Co.			Lennox Foundry Co.			Lelean Sack		Thompson	
						Low-pressure current steam			Velox H.P. steam			Equifex. Sat. H.P.						
	L.O. size Oval form with vacuum producing and hot air apparatus	M.O. size Oval form with vacuum producing and hot air apparatus	L.M.C. size Circular form with vacuum producing and hot air apparatus	L.C. size Circular form with vacuum producing and hot air apparatus		Portable furnace heated (Model F.)	Fixed furnace or steam-heated (Models P. and P.P.)	Model F.Q.Q. 2 mounted on Foden lorry, furnace-heated	Type A.2 fixed	Type A.3 fixed and large C.I. portable	Type B.1 small stationary or semi-portable	Steam, No. 3	Stationary, No. 4		Portable, downward displacement		Mule pack portable field	
Dimensions : Height . . . . Width . . . . Length . . . . Diameter	6′ 3′ 7″ 7′ —	4′ 2″ 2′ 7″ 7′ —	— — 7′ 3′ 6″	— — 7′ 4′		— — 5′ 3′	— — 5′ 3′ 7″	— — 6′ 3′ 7″	— — 7′ 6″ 4′ 3″	— — 7′ 3′ 6″	— — 5′ 3′	— — 7·6″ 4·3″	— — 7′ 3′ 6″		4′ 6″ 2′		— —	
Capacity (cubic ft.) . .	120	60	67	88		35½	50	120 (60 each)	106	67	35	106	67		13·3		3·4	Each box.
Working pressure (lbs. per sq. inch)	Jacket 30 Chamber 20	30 20	30 20	30 20		Atmospheric	5	5	15	15	15	20	20		Atmospheric		tmospheric	
Temperatures (obtained during disinfection) . .	259° F.	259° F.	259° F.	259° F.		214° F.	225° F.	225° F.	249° F.	249° F.	249° F.	239° F.	239° F.		212° F.		212° F.	
Fuel : (*a*) Paraffin . . (*b*) Coal . . . . (*c*) Steam for existing supply.	(*b*) or (*c*)	(*b*) or (*c*)	(*b*) or (*c*)	(*b*) or (*c*)		(*b*)	(*b*) or (*c*)	(*b*)	(*b*) or (*c*)	(*b*) or (*c*)	Normally (*a*) Velox Steam Generator	(*b*) or (*c*)	(*b*) or (*c*)		Normally (*a*)		Crude oil and water fuel	
Steam Consumption (lbs. per hour from existing supply)	360	200	220	250		—	130	300 (for 2)	150	100	—	160	130		—		—	
Fuel requirements (*a*) To start . . (lbs. coal)	112*	84*	84*	100*	* Approximate.	75	80	From Foden steam lorry	75*	70	Negligible	50	40					
(*b*) Per hour (lbs. coal)	56*	40*	40*	50*	* Approximately.	20	15	per chamber 30	36	35	⅞ gal. (*a*)	20	16		3 pints	Paraffin per load	Oil, 7 pints Water, 4 pints	
Time to raise steam in boiler . .	60	60	60	60	,,	90	90	From Foden steam lorry	90	90	10	60	60		—	—	—	
No of blankets which can be disinfected at one time	120	60	60	80		30	40	50 each 100	100	60	35	100	60		25		7 per box (i)	(i) per 1st hour, 14. per 2nd and subsequent, 20–35.
No. of kits which can be disinfected at one time	90	45	45	60	One kit= Trousers 1 pr. Socks 1 pr. Pants 1 pr. Puttees 1 pr. Shirt 1 Valise 1 Tunic 1	20	27	40 each	80	45	22	80	45		6	Winter kits with bedding	—	
	—	—	—	—	*Approximate Times*									*Times*				
	10	5	5	7	← Load →	5	5	5 (each)	8	5	5	8	5	1. Unpacking and setting up . .	8		6	
	30	30	30	30	← Disinfect →	30	30	30 (each)	20	20	20	20	20	2. Loading	6 (i)	(i) Whilst steam is being raised (ii) Concurrent with refilling of lamp. (iii) Being got up during 1st unloading and 2nd loading. (iv) Can be done whilst steam is being raised again.	2	
	20	20	20	20	← Dry →	20	20	20 (each)	20	20	20	15	15	3. To produce steam	16		16	
	10	5	5	7	← Unload →	5	5	5 (each)	8	5	5	8	5	4. For steam to pass through . .	22		11	
														5. Additional time for disinfection to be completed	5		3	
														6. Unloading and drying by shaking	7		2	
	70	60	60	64	← Totals →	60	60	60	56	50	50	51	45	Totals, 1st load	58		40	
														Reconditioning Refill lamp . . . . ,, boiler . . . . . . Produce steam	2 (2) (ii) (5) (iii)		1	
														2nd load and subsequent 1. Loading	6 (i)		nil	Ready.
														2. Steam to pass	22		11	
														3. Additional	5		3	
														4. Unloading and drying by shaking	7		2 (ii)	(ii) Can be excluded.
															34	Total 2nd load	14	
	1	1	1	1		1	1	1	1	1	1			Attendants No.	2		2	

APPENDIX 16

Method of sterilization of shaving brushes

1. Place the brushes in warm water between 70° F. (21·1° C.) and 80° F. (26·7° C.); add sodium bicarbonate, one teaspoonful to the pint and allow to remain for half an hour.

2. Add formalin to the above so that the solution contains 5 per cent. formalin. Allow to stand half an hour, taking care to keep the temperature up to 70° F.

3. Remove the brushes and allow them to dry.

4. Repeat the process.

APPENDIX 17

Suggested orders for the prevention of trench foot

(*See also* Official History of the War, Medical Services, Hygiene of the War, Vol. II.)

1. This condition is caused by :—
   (*a*) prolonged standing in cold water or mud ;
   (*b*) the continual wearing of wet socks, boots, and puttees.

2. It is brought on much more rapidly when the blood circulation in the feet and legs is interfered with by the use of tight boots, tight puttees or the wearing of anything calculated to cause constriction of the lower limbs.

3. It can be prevented or diminished by :—
   (*a*) improvements to trenches leading to dry standing and warmth ;
   (*b*) reducing the time spent in the trenches as far as the military situation permits ;
   (*c*) regimental arrangements ensuring that, so far as is possible, men enter the trenches warmly clad in dry boots, socks, trousers and puttees, and with the skin well rubbed with warm whale oil or anti-frostbite grease ;
   (*d*) provision of warm food in the trenches, when possible ;
   (*e*) movement when possible, so as to maintain blood circulation ;
   (*f*) the provision of warmth, shelter, hot food and facilities for washing the feet and drying wet clothes for men leaving the trenches.

4. In order to minimize the prevalence of trench foot, commanding officers will be held responsible that the following instructions are carried out unremittingly and under the strictest supervision :—
   (*a*) Before entering the trenches the feet and legs will be washed and dried, then well rubbed with warm whale oil or anti-frostbite grease and dry socks put on. It is of the utmost importance that warm whale oil or anti-frostbite grease should not merely be applied but thoroughly rubbed in until the skin is dry. Unless this precaution is systematically carried out, the oil and grease become in a great measure valueless.

(*b*) A second pair of dry socks will be carried by each man, and, where possible, battalion arrangements will be made for socks to be dried and re-issued during each tour of duty in the trenches.

(*c*) While the men are in the trenches boots and socks will be taken off from time to time, if circumstances permit, the feet dried and well rubbed, and dry socks put on.

(*d*) On no account will hot water be used, nor the feet held near a fire.

(*e*) Where possible, hot food will be provided during tours of duty in the trenches.

(*f*) Where circumstances permit, long gum boots will be put on while the men's feet are dry before they enter wet trenches, in order that they may start their tour of duty with dry feet.

(*g*) When gum boots are worn, it is well to support the socks by some form of fastening such as a safety-pin, to prevent them from working down the heel. On no account will anything in the form of a garter be worn.

(*h*) Where conditions are favourable, regimental rest posts will be instituted in proximity to the trenches, where men who show signs of suffering from exposure can be promptly attended to.

5. Under brigade arrangements, provision will be made for the washing and drying of feet in reserve billets, for the exchanging of wet socks for dry ones, and, if possible, the sending ot the latter to the trenches, and for drying and brushing clothes. Steps will be taken to ensure that men make use of these arrangements.

6. Long gum boots should be issued to the fullest extent of the supply available, and every effort should be made to procure all that are necessary for men holding waterlogged trenches. The distribution of these boots depends upon the necessity for their use according to the nature of the trenches held by divisions, brigades, etc., and the distribution should, therefore, be made, not according to the numerical strength of formations, but according to the nature of the trenches which formations are required to hold.

APPENDIX 18

Details of Standard Sanitary Appliances

Appliance	Capacity	Size.	Materials required	Brief description and remarks on construction
Incineration 1. Open circular turf incinerator.	For 250 men.	Internal diam. 3′ 6″. Height 4′ 6″.	Turves 1′×9″ cut out on the spot. 40′ metal for firebars; 4 sheets tin 2′×9″, to roof air inlets.	Fig. 38.
2. Closed beehive incinerator.	For 500 men	External diam. at base 6′, at top 4′ 8″, height 4′ 6″. Concrete base 7′×7′×4″. Height 7′ to base of chimney.	Bricks, 1,200. Lime mortar, 10 cwt. Cresol drums, 3. Angle iron, 12′. Firebars, 52′. Sheet metal for doors—15″×15″ and 12″×12″. Concrete, $\frac{1}{2}$ cu. yard.	Fig. 41. Circular—ledge at 1′ high for bars—4 air inlets 9″ square facing diagonals of concrete base. Top feed door 15″ square. Raking door 12″ square.
3. Open corrugated iron incinerator.	For 250 men	Height 4′ 6″, width each way that of standard sheet of C.I.	Standard C.I. sheets, 4, cut down. Wire (12 S.W.G.), 20′. Firebars—24′.	Fig. 39. Rectangular—4 air inlets 12″×8″, firebars through holes at 1′ high.
4. Semi-closed corrugated iron incinerator with graduated feed.	For 250 men	Height 6′. Width as in 3.	C.I. sheets, 4 for walls, 2 for shelves, hood and grate. Wire (12 S.W.G.), 20′. Bars, 20′.	Fig. 40.
5. Semi-closed corrugated iron incinerator with oil and water apparatus. (*See* Item 11.)	For 250 men	Height 4′ 6″. Width as in 3.	C.I. sheets, 4 for walls, 1 for hood and shelves. Bars, 8′. (Oil and water apparatus not included.)	Fig. 40.

6. Bailleul incinerator	For 1,000 men	Width 4′ 6″. Length 4′ 3″. Height in front 4′ 6″, at back 4′ 9″. Concrete base 5′×6′×4″.	Bricks, 1,000; oil drums for chimney, 5. Lime mortar, 10 cwt. Sheet iron for top feed door, 2½″×2′; for raking door, 12″×9″. Firebars, 30′. Angle iron, 12′. Hinges, 6″ T.2. Rivets, iron, ½ lb. Wire (12 S.W.G.), 25′. Concrete, ½ cu. yard.	*Vide* Fig. 42.
7. Improvised Bailleul incinerator.	For 1,000 men	Width 4′ 6″. Length 4′ 6″. Height in front 4′ 6″, at back 5′.	Biscuit tins, 62. Oil drums for chimney, 5. Wire (12 S.W.G.), 25′. Sheet metal or C.G.I. flattened, 3′×3′ and 1′×1′, and 2 sheets 4½′×2′. Firebars, 30′. *Note.*—1. Metal for firebars may be light Decauville rails, angle iron, piping, expanded metal, bhoosa wire, etc., as available. 2. Chimneys of closed incinerators should be carried to a height of 15 feet from ground level if possible. 5 gal. cresol drums (length 1′ 5″), oil drums (length 1′ 5″) may be used.	Rectangular—built on same principle as No. 6 above: top feed door set in sloping upper surface of metal—baffle plate of C.G.I. Tins filled with earth and wired together form walls which become consolidated by burning after erection—Chimney carried to height 15′. Air inlets made by omitting one tin back and front below bars. Raking hole left by omitting one tin below bars. Firebars laid on 2 supports let into walls above bottom layer of tins.
8. Horsfall destructor	For 1,000 men	No. 3 trade pattern.	Supplied complete.	*Vide* Fig. 43. Rectangular; baffle plates; pedestal to support burning mass; metal cased lined with firebricks; collapsible and portable, weight 30 cwt.

APPENDIX 18—*continued*

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
9. Shed for destructor	For 1,000 men	10′×10′×10′	Concrete base 10′×10′×4″, 1 cu. yd. concrete. C.G.I. 2′×7′—11. Timber, 3″×2″—44′. Scantling, 160′. Nails, 4″—1½ lb.; 2″—½ lb., G.C.H. nails and curved washers—114.	Rectangular shed.
10. Pit destructor ..	1 for each military station.	10′ diam., 15′ high (10′ to top of cylinder; cone 5′).	Red bricks for sides, top and firebar shelves and approaches—4,500. Fire-bricks for lining chamber—2,000. Lime mortar, 25 cwt. Fireclay, 20 cwt. Concrete, 2 cu. yds. Fire-bars, steel tramway or railway rails, approx. 130 F.R.; supported on cross rails at rear, middle and front, 30 F.R. Sheet metal door flanged to fit in frame for top feed 2′×2′ 6″ opening. Sheet metal doors and metal frames for draught and raking door. Draught hole 1′ high and at least 3′ broad with regulating shutter. Door to interior	Dug-out destructor with draught and raking door in cut-out face of bank. Top feed opposite raking door—carts tip direct to feed door—chimney must be adequate in diameter and height, viz. 15″ internal and 12′ high. Fire-bars slope towards raking door. The top is built "corballed" or set back.

			2′ high and at least 3′ broad.	
11. Oil and water flash apparatus.	—	—	Biscuit tin for container—1. Strip iron for stand, 1″ × ⅛″ — 20 F.R. Taps, 2. Angle iron as required for trough. Sheet metal, 2′ × 1′.	Tin container divided into 2 compartments for oil and water respectively; oil compartment is twice size of water; each compartment fitted with tap; angle iron forms a trough to convey oil and water to flash pan; metal flash pan fitted with diagonal ridges of metal (*vide* Fig. 64); tin container rests on stand made of strip iron.
Manure Disposal.				
12. Single trench incinerator.	For 50 horses	9′ long; 1½′ wide. 18″ deep at mouth, rising to 6″.	Bars 12′. Expanded metal (2″ mesh), 9′ × 3′.	*Vide* Fig. 29. Oil and water apparatus required to help combustion. (*See* item 11 above.) Trench with splay mouth facing wind; whole covered by 4 bars supporting expanded metal.
13. Cross trench incinerator.	For 100 horses	Each trench = 8′ long, 1½′ wide, 1½′ deep. Circular hollow, 3′ diam., 1½′ deep.	Bars, 48′. Cresol drum, 1. Expanded metal, 9′ × 3′—4 pieces; 3′ × 3′—1 piece.	*Vide* Fig. 29. 4 trenches joining at circular hollow to form a cross, which is covered by expanded metal supported on bars laid across trenches. Oil and water apparatus required to help combustion. (*See* item 11 above).

APPENDIX 18—*continued*

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
Manure Disposal—*cont.* 14. Basket incinerator	For 100 horses	4′ wide, 4′ long, 1′ deep.	150′ of iron bands. Four 6-ft. angle iron pickets or 4 tins to support corners.	*Vide* Fig. 30. 1″ mesh in tropics. 2″ mesh outside tropics.
15. Tight pack (trenched)	For 400 horses	9′ wide, including trench on each side, 1½′ wide. Length for one week, 30′.	Oil, 2½ galls. per week. (Waste motor oil is suitable.)	*Vide* Fig. 31A. Earth covering 6″ deep. Daily pack—6′ wide, 4′ high, 4′ long.
16. Tight pack (with platform).	For 400 horses	Platform, width, 18′. Length, including 4′ margin at each end=22′ for one week's completed pack.	Concrete platform of 18′×22′=396 sq. ft.=4 cu. yds. concrete. If oiled earth used for base, waste motor oil, 5½ galls. per week, will be required. Sacking, 20 yards×6′.	*Vide* Fig. 31B. Weekly pack—10′ wide, 5′ high, 14′ long.
17. Manure collecting pit	For 400 horses	Area of concrete platform, 14′×6′. Height of walls=4′ 6″.	Bricks, 700; mortar, 7 cwt. ¾ cu. yd. concrete. Sheet iron for baffles in strips 6″ wide and totalling 20 yards in length.	*Vide* Fig. 18. Two rectangular bays formed by partition wall, 6′×4′ 6″. Floor slopes to gutter in front protected by overhanging metal baffle and draining to sump. Gutter 6″ wide, 6″ deep; sump 1′ sq. by 15″ deep. All joints in metal overhang must overlap; floor bevelled to meet gutter.

Water Disposal				
18. Soakage pit ..	For 250 men	Two pits, each 4′×4′×4′.	Stones or burnt perforated tins for filling.	Cubical pit filled to within 6″ of surface with stones, covered by layer of sacking, 6″ earth and turf replaced.
19. Herring-bone drainage.	For 250 men	20′×40′	No materials required	*Vide* Fig. 34. Trenches 1′ wide, 1′ deep.
20. Ablution bench—improvised.	100 men	18-foot run, double-sided.	C.G.I. sheets, 7′×2′—5 sheets. 18′ per 100 men. Half oil-drums longitudinal section for trough—3. Stakes, 4′, as legs—12. Nails, 2″—1 lb.	Sloping washing benches with collecting trough at end leading to soap tray.
21. Ablution bench—standard pattern.	100 men	Two 9′ double-sided benches.	Timber :—3″×2″—31 F.R. „ 3″×1″—33 F.R. „ 9″×1″—63 F.R. „ 6″×3″— 7 F.R. ¾″ water piping—14. Nails, 3″—1½ lb. „ 2″—½ lb. Screw-down cocks—4. Unions—4. Red lead, etc., as required.	*Vide* Fig. 35. Double-sided benches. Central trough sloped to one end. 4 taps each bench. Duckboards.
22. Improvised strainer trap.	1 for each soak pit.	—	Tins—2 different sized biscuit tins perforated at bottom.	*Vide* Fig. 33. One tin inside another, perforated, packed with hay, straw, etc.
23. Cold water trap ..	1 for each soak pit.	Minimum— 3′ long, 2′ deep, 1½′ wide.	Timber, 6″×1″—89 F.R. „ 2″×1″—18 F.R. „ 9″×1″— 6 F.R. „ 3″×3″— 5 F.R. G. sheet iron, 2′×2′—2. Nails, 2″—2 lb. „ zinc clouts—½ lb. Bucket (perforated)—1.	*Vide* Fig. 32. Rectangular—3-baffle trap. Baffles to be removable or leave ample space beneath for cleaning and to be spaced equally. Internal corners to be rounded.

APPENDIX 18—*continued*

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
Latrines 24. Shallow trench latrine.	5 for first 100 men. 3 per cent. for remainder. 10 per cent. for officers, W.Os. and sjts.	3′ long, 2′ deep, 1′ wide.	No materials required.	*Vide* Fig. 23. 2′ between trenches.
25. Deep trench latrine (5-seater).	5 seats for first 100 men. 3 per cent. for remainder.	Trench :— 10′ long, 3′ wide, 6′–8′ deep.	Timber, 9″ × 3″—35 F.R. „ 6″ × 1″, T & G—160 F.R. „ 3″ × 1″—100 F.R. „ 3″ × 1½″—110 F.R. Hessian, 4′ wide—60′. Nails—2 lb. Heavy oil—2 galls. Hinges, butts, 2″—5 prs. Sheets, iron, 10″ × 7″—5 sheets. Sheets, C.G.I., 4′ long—14 sheets. 60 cone head G.I. nails and washers.	*Vide* Fig. 24. Trench revetted at sides. Anti-fly oiled sacking laid down 4′ all round trench; wooden fly-proof cover of T. & G. wood on strong base, self-closing lids, urine deflectors, sloping back. Height to seat, 19½″.
26. Bucket latrine with shelter.	5 for each 100 men.	Height, maximum, 6′ 4″. Width, 3′ 2″. Length—allow 2′ 6″ per seat.	For 5 seats with shelter :— Sheets, C.G.I., 4′ long—14 sheets. Hessian, 70 sq. ft. Timber:—3″ × 1½″—100F.R. „ 3″ × 1″—286 F.R. „ 6″ × 1″, T. & G. —70 F.R. Butt hinges, 2″—5 prs.	*Vide* Fig. 25. Latrine buckets fitted with fly-proof covers and overhead cover provided.

			Pivot hinges and plates—5 prs. 60 cone head G.I. nails and washers. 2½″ nails—5 lb. 4″ ,, —3 lb. 2″ ,, —2 lb. 1 ,, —1½ lb. (lath nails).	
27. Pail latrines, portable and fly-proof.	To fit latrine bucket.	Hole, 13″ × 10″, oval in shape, with point of oval to front.	Timber :— 3″ × 1″—8 F.R. 3″ × 2″—22 F.R. 2″ × 1″—1′ 8″ F.R. 3″ × ¾″—1′ 8″ F.R. 6″ × ¾″, T. & G.—42 F.R. T-hinges—2 prs. 2″ nails—2 lb. Sheets, C.G.I., 4′ long—1 sheet.	Single seats for use on buckets or drums; lids self-closing.
28. Otway pit for excreta.	1 for 100 men	10′ long, 3′ wide, 6′–8′ deep.	Timber :— 6″ × 1″—160 F.R. 4″ × 3″— 36 F.R. 3″ nails—4 lb. Hessian, 4′ wide and 54′ long. Oil—2 galls.	Same size as deep trench latrine; sides revetted; pit covered with stout wooden covers extending 1′ in all directions beyond pit; oiled canvas covers the wooden cover and extends 4′ all round pit; 6″ earth layer on canvas; entrance made through cover towards one end by fitting metal box, *e.g.* rubbish bin, with bottom removed; at other end is cut escape hole, 6″ in diam., for flies; fly trap superimposed over escape hole.

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
Urinals				
29. Shallow trench urinal	For 250 men	10′ long, 3′ wide, 6″ deep.	No materials required	Turf and earth piled on one side and at the ends; trench use from remaining side; earth loosened to depth of 6″ over floor of trench.
30. Single funnel drum urinal.	1 for 20 officers or men.	Height to edge of drum—2′.	Oil or cresol drum—1. Sheet tin pipe 3″ diam., 3′ long.	Half drum mounted on pipe which is sunk into 2′ cubical soak pit.
31. Four-funnel urinal	1 for 100 men	Height to front edge of funnel —2′. Mouth of funnel 1′ in diameter.	Sheet tin—4 biscuit tins. Stakes, 6′ 6″—5. Canvas, 32 sq. ft.	*Vide* Fig. 28. Funnels should vary slightly in height. Cross screens make 4 compartments. Soak pit—4′ cube.
32. Trough urinal.. ..	1 for 100 men	8′ long. Front edge of trough slopes from 2′ 3″ to 2′ in height.	Timber:— 3″×2″—20 F.R. 6″×1″—2 F.R. Nails, 2″—½ lb. C.G.I. sheet, 8′—1. Sheet tin for pipe—1 biscuit tin.	*Vide* Fig. 27. Trough 8″ in diam. Soak pit—4′ cube.
Cooking				
33. Cookhouse shelter ..	Minimum size	10′ long, 10′ wide, 8′ high in front slop-	Timber:— 3″×3″—90 F.R. 3″×2″—170 F.R.	*Vide* Fig. 21. Materials for fixtures not included.

		ing to 6′ 6″ at back.	C.G.I. sheets :— 8′—12 ; 7′—5 ; 6′—5 ; 5′—5. Wire nails, 4″—7 lb. " " 3″—3 lb. G.C.H. nails and washers—5 lb.	
34. **Portable food safe..**	1 for each cook-house.	2′ × 2′ × 2′ folds to 2′ × 2′ × 6″.	Timber :— 3″ × ¾″—100 F.R. Wire gauze—16 sq. ft. Hinges with screws—1 pr. Screws, 1¼″—12 for stops. Wire nails, 2″—3 lb.	Solid top and bottom ; sides, back and front of wire gauze on frames which pack flat inside top and bottom.
35. **Food safe** ..	1 for each cook-house.	6′ × 2½′ × 2½′.	Timber :— 2″ × 2″—54 F.R. 6″ × 1″—13 F.R. 3″ × 1″—38 F.R. Sheet zinc or tin for top, back and bottom—28 sq. ft. Hinges, 3″—1 pr. Staple and hasp—1. Meat hooks—3. Wire nails, 3″—3 lb. " " 2″—2 lb. Clout-headed nails, ¾″—1 lb. Hessian or wire gauze—45 sq. ft.	Top, back and bottom solid ; sides and door of wire gauze or canvas ; one central shelf of battens.
36. **Washing-up bench (improvised).**	1 for each cook-house.	8′ long, 2′ wide, 2′3″ high sloping to 2′ 1″.	C.G.I. sheets, 8′—1. Biscuit tin—1 for collecting trough and pipe. Timber :—rough, 3″ stakes, 3′ 6″ long—6 stakes ; 3″ × 1″—6. Nails, 3″—½ lb.	A galvanized iron bench sloping to a trough draining into a soak pit.

APPENDIX 18—*continued*

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
Cooking—*continued* 37. Washing-up bench (standard)	1 for each cook-house.	9′ 6″ long, 2′ 2″ wide, 2′ 7″–2′ 5″ high.	Timber :—2″ × 2″—13 F.R. ,, 2″ × 1″—33 F.R. ,, 3″ × 1″—41 F.R. ,, 6″ × 1″—18 F.R. ,, 6″ × 3″—6 F.R. ,, 6″ × 6″ × 1″. ,, 6″ × 6″ × 2″. C.G.I. sheets, 8′—1. ,, (20 gauge), 3′—1. ¾″ water pipe—4 F.R. Hoop iron, 1½″—1 F.R. Screw-down tap—1. Nails, oval, We 3″—3 lb. ,, zinc clouts—½ lb.	C.G.I. sheet bench with wooden lateral boards, water pipe and tap and collecting trough.
38. Improvised hay-box	For 6-gallon food container.	Improvised box, 2′ 4″ long, 1′ 9″ wide, 1′ 9″ deep.	Timber :—4″ × ¾″—65 F.R. ,, 1″ × ½″—25 F.R. Nails, 1½″—1 lb. Hinges, double T—1 pr. Hasp and fixing—1. Hoop iron, ½″—15′. Sack 1. Hay about 25 lb. *Note.*—A tea chest opened lengthways makes a very good size for a hay-box.	This allows 4″ packed hay all round container cage. Container cage made of hoop iron to fit size of container. Hay is packed all round and a sack packed with hay is placed over top.

Disinfectors				
39. Aldershot box, or packing case, downward steam.	—	—	Stout wooden box—1. Sheet metal lining—1. Screw clamp—4. 1″ metal piping, 4′, plus 1 elbow. Blankets, old, as required. Boiler, etc., any standard pattern or improvised as for Serbian barrel.	Any stout box, lined with metal lagged with blanket. Lid should fit tightly with blanket lagging and have screw clamps or heavy weight. Steam inlet pipe enters near top of box, escape is at bottom.
40. Serbian barrel ..	25 blankets	3′ × 2′	Barrel—1. Blanket, old for lagging lid. 1″ metal pipe, 2′ 9″—1. Safety valve filler. 1″ metal pipe, 2′ plus elbow. 1 steam pipe. Oil drum, 5-gall.—1. Stove pipe for chimney—1. Bricks for fireplace—20.	*Vide* Fig. 63. Barrel buried in earth bank, steam entrance near top, steam escape at bottom, lid heavy and lagged with blanket, boiler of 5-gallon oil drum with fireplace built underneath; safety valve and filler pipe projects 2′, steam pipe requires elbow, pipes lagged in with puddled clay.
41. Mule pack disinfector	27 blankets an hour	2 boxes, 17″ × 18″ × 32″ high.	Issued complete.	*Vide* Fig. 64. 1 complete mule load. 2 steaming boxes with hinged lids metal lined and lagged with blanket; steam from boiler fixed in metal fire box with chimney; heat from oil and water fire on flash pan.

APPENDIX 18—*continued*

Details of Standard Sanitary Appliances—*continued*

Appliance	Capacity	Size	Materials required	Brief description and remarks on construction
Disinfestors				
42. Orr's hut	70 blankets an hour.	Hut :—8′ long, 6′ wide, 6′ high Pit :—6′ long, 6′ wide, 5′ deep.	Erected by Royal Engineers.	A hut is built over a pit; hut requires double walls lagged with earth, stout door, escape vent for fumes. Metal floor perforated. Pit lined with old sheets of C.G.I. Braziers in pit provide hot air. Blankets suspended on wires at 6″ intervals arranged in 2 tiers. *Vide* Fig. 60.
43. Dug-out disinfestor	70 blankets	8′ wide, 6′ long, 7′ high.	Timber :— For sliding groove, 3″ × 1″—30 F.R. Uprights and cross-battens, 3″ × 3″—90 F.R. Steps, 6″ × 1″—30 F.R. C.G.I. sheets, 7′—20. Nails, 6″—7 lb. „ G.C.H. with washers—7 lb. Oil drums—6. Wire, G.I. (14 S.W.G.)—175′.	*Vide* Fig. 61. Dug-out lined with C.G.I. sheets; tight-fitting sliding door; wires at 6″ intervals arranged in 2 tiers.
Fly Traps				
44. Fly wires	10 for each cook-house.	2′ long.	Hay bale wire if available should be used.	Wires coated with "tanglefoot."

				Wires and tin trough in which "tangle-foot" is prepared can be carried in an oil drum.
45. Roller-towel trap ..	1 for each group of latrines.	5′ high, 2′ wide.	Timber :—For uprights and ends, 3″ × 3″—13 F.R. For stand, 3″ × 2″—4 F.R. For roller, 2″ round—3 F.R. For eaves and flaps to guard trough—6″ × ¾″—10 F.R. 3″ × 1″—6 F.R. Oil drum—1. Mixed nails—2 lb. Canvas 3′ wide—6 F.R. Handle improvised—1.	*Vide* Fig. 50. Roller turned by handle carries endless band of canvas which passes through arsenite solution in a trough. Solution should be safeguarded from animals.
46. Box trap	As required.	1′ 6″ cubical box on platform 2′ × 2′.	Timber :— For platform, 6″ × 1″—8 F.R. For frame, 2″ × 1″—20 F.R., ripped to make 1″ × 1″—40 F.R. Wire gauze—14 sq. ft. Canvas—14 sq. ft. Wire (14 S.W.G.)—6′. Hinges, 1¼″—1 pr. Catch to door—1. Mixed nails—2 lb.	*Vide* Fig. 49. Upper half of trap has canvas sides; lower half and top made of wire gauze; lower edge of gauze turned inwards to make a flange and leave narrow slit, ½″ deep, entrance for flies; canvas flaps to lower half may be added to give protection on windy days.
47. Californian trap ..	As required.	Cylinder: 3′ high, 1′ diam. Stand: 2′ 6″ long, 2′ 6″ wide. Walls 1′ 6″ high.	Timber :— 6″ × 1″—30 F.R. 2″ × 1″—6 F.R. Nails, mixed—1 lb. 1″ hoop iron—10′. Wire gauze—15 sq. ft.	Cylindrical trap of perforated zinc or wire gauze with inverted cone of same material inside. Wooden stand is protected on two sides by walls 1½′ high and angle so formed placed to windward.

APPENDIX 19

Useful Data

(Headings are arranged in alphabetical order)

ACCOMMODATION

Barracks as in Appendix 10.

India Plains—90 sq. ft. (1,440 cu. ft.).

Verandah 10 ft. wide in clear all round.

Hills—66 sq. ft. (660 cu. ft.).

Verandah 6 ft. wide in clear in front.

Offices and regimental shops—50 sq. ft. (500 cu. ft. per head).

Dining-rooms (Seating space)—9 sq. ft. per head.

Glass area of windows—$\frac{1}{10}$ floor space.

Latrines—6 per 100 men.

Urinals—4 per 100 men.

Kitchens—2½–3 sq. ft. for each person in mess.

Billets.—40 sq. ft. and 400 cu. ft., if available.

Camps.—Bell tents—infantry 10, cavalry 8.

Latrines—5 for first 100, 3 for each 100 after.

Urinals—1 trough 8 ft., or 4 funnels per 100 men.

Transports.—Area 10·6 sq. ft. Cubic space 80 cu. ft.

Sizes.—Bell tent. 180 sq. ft. (480 cu. ft).

Army hut average 60 ft. long by 20 ft. broad; one pair of windows to each 10 ft. run.

Conversion factors

1 gramme is the weight of 1 cubic centimetre of pure water at 4° C.

1 gramme	= 15·43 grains.
1 gramme	= 0·035 oz.
1 kilogramme	= 2·204 lb. (2 lb. 3¼ oz.).
1 ounce (avoirdupois)	= 28·35 grammes.
1 grain	= 0·065 grammes.
1 ounce (Troy)	= 31·1 grammes.
1 cubic centimetre	= 0·035 fluid ounces.
1 cubic centimetre	= 16·23 minims.
1 litre (1,000 c.c.)	= 35·196 fluid ounces.
1 litre ,,	= 1·76 pints.
1 fluid ounce.	= 28·42 cubic centimetres.
1 pint	= 568·18 cubic centimetres, 0·57 litres.
1 gallon	= 4·54 litres.
1 gallon pure water	= 10 lb.
1 gallon	= 0·16 cubic feet.
1 cubic foot of water	= 6·23 gallons.

Conversion factors—continued

1 pound avoirdupois	= 7,000 grains—453·59 grammes.
1 inch	= 0·0254 metres.
1 metre	= 39·37 inches.
1 centimetre	= 0·39 inches ($\frac{2}{5}$ inch).
1 millimetre	= 0·039 inches ($\frac{1}{25}$ inch).
1 kilometre	= 0·62 miles.

Conservancy

1 cubic foot of fæces (packed) weighs 73 lb., average with liquid 75 lb.

Daily.—Fæces per man=5 oz. Indian, 12 oz.

Fæces per battalion about 313 lbs.=about $4\frac{1}{2}$ cu. ft., of which about 50 lb. are actual solids.

Urine per man=50 oz.

,, 100 men=30 gallons.

Kitchen slop water—1 gallon per man.

Ablution water—5 gallons per man.

Horse manure—8 lb. per horse.

100 horses—12 barrow loads—1 nine-foot burning trench.

Dry refuse—1,000 men, 925 lb. (32 cu. ft.).

Fuel for excreta—2 lb. sawdust per 10 men.

Constructional

Mortar—Cement=Cement 1, sand 3–4 (will not stand heat).

,, Lime=Lime 1, sand 3–4.

Concrete=Cement 1, sand 2, aggregate 3–5.

1 cubic yard=6 cu. ft. cement, 12 cu. ft. sand and 18 cu. ft. aggregate (hard loose material free from earth).

Bricks.—Size with mortar, $9 \times 4\frac{1}{2} \times 3$ inches.

Absorption. Good bricks should not absorb more than 16 oz. water (10 per cent.).

Weight—Wire cut (clay) $8\frac{1}{2}$ lb. (approximately).

Fletten ,, $5\frac{1}{2}$ lb. ,,

Average weights per cubic foot:—

Brick—112 lb.
Concrete—120 lb.
Loose earth—95 lb.
Clay—125 lb.
Steel—489·6 lb.
Deal—43 lb.
Oak—54 lb.
Teak—70 lb.
Ice—$57\frac{1}{2}$ lb.

Average weights per cubic foot—*continued*

Water—62·425 lb.

India rubber—62 lb.

Glass—184 lb.

1 wheelbarrow (navvy) holds 1/10 cu. yd. of clay.

1 ,, (ordinary) holds 1/14 cu. yd. of clay.

1 service spade—Total length, 3 ft. 2 in.
Handle length, 2 ft. 2 in.
Blade length, 1 ft.
,, breadth, 8 in.

1 G.S. shovel—Total length, 3 ft.
Handle length, 2 ft. 4 in.
Blade length, 9 in.
,, breadth, 8 in.

Measures

Area.—144 square inches = 1 square foot: 9 square feet = 1 square yard.

4,840 square yards = 1 acre.

1 square metre = 1·2 square yards = 10·8 square feet.

1 acre = 70 yards × 70 yards (almost).

Capacity

20 fluid ounces	=	1 pint.
2 pints	=	1 quart.
4 quarts	=	1 gallon.
1 gallon	=	4½ litres.
1 litre	=	1¾ pints.
1 gallon	=	277¼ cubic inches.
1 gallon water	=	70,000 grains.
1 ounce water	=	437·5 grains.
½ fluid ounce	=	1 tablespoon.

Cubic measure

1,728 cubic inches	=	1 cubic foot.
27 cubic feet	=	1 cubic yard.
1 cubic metre	=	1·3 cubic yard.
40 cubic feet	=	one shipping ton.

A 5-gallon oil drum—
External—17 in. high × 11 in. diameter,
Internal—15½ in high × 10½ in. diameter,
= 1,350 cubic inches approximately.

Length

1,760	yards	=	1 mile.
5	miles	=	8 kilometres.
11½	miles	=	10 nautical miles (approximately).
100	links	=	1 chain = 22 yards (cricket pitch).
1	fathom	=	6 feet.
1	halfpenny	=	1 inch across.

Measures of temperature

Centigrade scale: Freezing point = 0° C.
Boiling point = 100° C.

Fahrenheit scale: Freezing point = 32° F.
Boiling point = 212° F.

To convert Fahrenheit to Centigrade:

Deduct 32 and multiply remainder by 5/9.

To convert Centigrade to Fahrenheit:

Multiply by 9/5 and add 32.

Ventilation

Average requirements = 1,000 cubic feet of fresh air per head per hour.

An air velocity of 3 feet per second is a perceptible draught.

Atmospheric pressure = 15 lb. per square inch (approximately).

Suitable Katathermometer readings for indoors are—Dry kata = 6, wet kata = 18.

Time

1 degree of longitude = 4 minutes in time.
1 hour = 15 degrees of longitude.

Weight

16 oz. = 1 lb.
112 lb. = 1 cwt.
20 cwt. = 1 ton.
1 lb. = 7,000 grains.
14 lbs. = 1 stone.
12 pennies = 4 oz. (approximately).
3 pennies = 1 oz.

Measurements :—

Superficial Space

Area of rectangle and square = the length multiplied by the breadth.

Area of rhombus or rhomboid (in which the opposite sides are parallel) = the base multiplied by the perpendicular height.

Area of trapezoid = half the sum of the two parallel sides multiplied by the width.

Area of triangle = half the product of the base and the height.

Area of regular polygon = the sum of the sides (perimeter) multiplied by half the perpendicular (drawn from the centre to the middle point of any side).

Area of parabola = the base multiplied by two-thirds of the height.

Area of circle = the square of the diameter multiplied by 0·7854 or the square of the radius multiplied by 3·1416.

Area of ellipse = the product of the long and short diameters multiplied by 0·7854.

Area of segment of a circle = the cube of the height divided by twice the length of the chord added to two-thirds of the product of the chord and the height. NOTE.—When the segment is greater than a semicircle, find the area of the circle and deduct the area of the smaller segment.

Area of sector of a circle = half the product of the arc multiplied by the radius.

Area of sphere = diameter squared, multiplied by 3·1416, or four times the square of the radius multiplied by 3·1416.

Cubic space

Volume of cube or rectangular room = the length multiplied by the breadth multiplied by the height.

Volume of prism = the area of the base multiplied by the height.

Volume of cylinder = the area of the base multiplied by the height.

Volume of cone or pyramid = the area of the base multiplied by one-third of the perpendicular height.

Volume of dome (segment of a sphere) = the area of base multiplied by two-thirds of the height.

Volume of sphere = the cube of the diameter multiplied by 0·5236, or four-thirds of the square of the radius multiplied by 3·1416.

Volume of wedge = the area of the base multiplied by half the perpendicular height.

Volume of frustum of cone or pyramid = the sum of the areas of the two ends of the frustum and the square root of their product, multiplied by one-third of the height of the frustum.

The cubical capacity of a marquee used as a hospital ward may be found by dividing it into :—(*a*) body—a solid rectangle with a half cylinder at each end ; (*b*) roof—a solid triangle and two half cones.

Regulations relating to hygiene and sanitation

King's Regulations, 1928 = K.R.

Regulations for the Medical Services of the Army, 1932 = Regs. M.S.A.

Regulations for Engineer Services, 1930, Pt. 1 = R.E.S.

Regulations for Supply, Transport and Barrack Services, 1930 = S.T. & B. Regs.

Regulations for the Allowances of the Army, 1930 = A.R.

Responsibility for efficient supervision and the remedy of sanitary defects, etc.
K.R., paras. 71, 84, 1265.
Field Service Regs., Vol. 2, Sec. 87, para. 3, page 173.
,, 108 ,, 12 ,, 210.
,, 115 ,, 6 ,, 218.

Barracks and hospital buildings—construction of
Barrack Synopsis.
Regs. M.S.A., paras. 44, 45, 180, 186, 312.
S.T. & B. Regs., para. 529.

Barracks and hospital buildings—maintenance of
R.E.S., paras. 91, 92, 95. Table "L," paras. 110–114.

Barracks, cleanliness of
K.R., paras. 1287–1295.
S.T. & B. Regs., paras. 552–561.
Regs. M.S.A., para. 180.

Barracks—Latrines, urinals and drains
K.R., paras. 1292–1293.
Regs. M.S.A., para. 181.
S.T. & B. Regs., Appendix 20, 21.
A.R., para. 563.
Pamphlet—The Care of Barracks.

Barracks—ventilation and lighting
K.R., paras. 1291, 1310.
Regs. M.S.A., para. 181.
S.T. & B. Regs., para. 540.

Institutes and messes
K.R., para. 1558.
Regs. M.S.A., para. 184.
Pamphlet—Management of Regimental Institutes.

Kitchens, dining halls, provision stores, etc.
Manual of Military Cooking and Dietary.
K.R., paras. 1413, 1414.
Regs. M.S.A., para. 181.
Management of Soldiers' Messing.

Water supply
K.R., para. 1310.
Regs. M.S.A., para. 185.

Cleaning articles
A.R., paras. 503, 518, 585.

Barracks, inspection of
K.R., paras. 1287, 1288, 1289.
Regs. M.S.A., paras. 17, 180, 181, 182.
For preparation of Special Sanitary Reports, *see* Regs M.S.A., Appendix 1.

Bedding for troops
K.R., paras. 1237, 1290.
Regs. M.S.A., para. 181.
S.T. & B. Regs., paras. 740–747.
A.R., para. 503.

Animals in barracks
K.R., para. 1294.

Detention rooms, guard rooms, etc.
K.R. paras. 720, 723, 724.

Workshops—hygiene precautions, etc.
Regs. for Royal Army Ordnance Services, 1929, Part 1, para. 160.

Married quarters
K.R., paras. 1315, 1341.
Regs. M.S.A., para. 180.
S.T. & B. Regs., paras. 552, 553.

Disinfection, etc.
K.R., para. 1290.
Regs. M.S.A., paras. 588–608 and Appendix 2.

Disinfectants
S.T. & B. Regs., paras. 557–561.
Regs. M.S.A., paras. 590–606 and Appendix 4.

Anti-fly stores
A.C.I., 50 of 1933.

Fuel for all purposes
A.R., paras. 132, 133, 141.

Army schools—inspection of
Regs. M.S.A., paras. 46, 186, 608.

Courses of instruction in hygiene, etc.
Regs. M.S.A., paras. 47, 176, and Appendix 5.

Other subjects concerning the health of the troops
K.R., paras. 529, 752, 753, 772, 773, 949, 956, 969, 1104, 1105.

Sanitation and hygiene on field service. General functions of the medical services in the field
Field Service Regs., Vol. 1, 1930, Chap. 5, para. 1 (iii).
,, 12, Sec. 68, para. 4.
,, 12, Sec. 76, para. 1.

Regimental sanitary organizations of field units
Field Service Regs., Vol. 1, 1930, Chap. 16, Secs. 145, 149, 154.

Duties regarding water supply, etc.

Field Service Regs., Vol. 1, 1930, Chap. 16, Sec. 153.
Field Service Regs., Vol. 2, 1929, Sec. 115, para 6.

Camping arrangements, etc.

Field Service Regs., Vol. 2, 1929, Sec. 87, para. 3.
Field Service Regs., Vol. 2, 1929, Sec. 108, para. 12.

In addition to above, useful information regarding hygiene organization in the field is given in the Field Service Pocket Book, 1932, Chapter XI, Secs. 50 and 51, 1932.

Water

1 gallon weighs 10 lb. Salt water 10·272 lb.
1 cu. ft. contains 6¼ gallons.
Regimental water cart holds 100 gallons at working capacity (110 nominal).
Water tank trailer holds 150 gallons at working capacity (180 nominal)
Canvas tank holds 1,500 gallons (1,800 nominal).
Camel pakhal (tank) holds 12½ gallons.
Mule pakhal holds 6½ gallons.
Water bottle holds 1¾ pints.
Biscuit tin holds 6¼ gallons.
Tea bucket holds 3 gallons.
Service camp kettle holds 22 pints.
Petrol tin holds 2 gallons.
Small bully beef tin after opening—9½ oz. approximately.
Horrocks' test white cup, ⅓ pint.
Table spoon, ½ oz.
Velocity of a stream, ⅘ surface velocity.
Rainfall in inches × ½ area in sq. feet = gallons (approximately).

Yield of a well.—Note the level of the water. Pump out to lower the level a measured distance, say 3 feet. Note the time taken to fill to the former level. The cross section area multiplied by the difference in the two levels multiplied by 6¼ divided by the time taken to refill in hours equals the yield in gallons an hour.

Yield of a stream.—Select a stretch of about 15 yards where the channel is uniform in width and depth with no eddies. Measure the average width and depth. Drop in a chip of wood or other float and note the time it takes to travel, say, 30 feet. Make several observations to obtain the average surface velocity in feet per second ; ⅘ of this will be the mean velocity.

The mean velocity multiplied by the sectional area equals the yield in cubic feet a second.

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